I-40 WEST CORRIDOR PROFILE STUDY

CALIFORNIA STATE LINE TO JUNCTION I-17

ADOT Work Task No. MPD 072C-14

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Draft Working Paper 6: Solution Evaluation and Prioritization

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Arizona Department of Transportation

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IN ASSOCIATION WITH:

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ACRONYMS

ADOT	Arizona Department of Transportation
BCA	Benefit-Cost Analysis
DMS	Dynamic Message Sign
EB	Eastbound
FY	Fiscal Year
IRI	International Roughness Index
I-17	Interstate 17
I-40	Interstate 40
LCCA	Life-Cycle Cost Analysis
MP	Milepost
MPD	Multimodal Planning Division
P2P	Planning to Programming
PES	Performance Effectiveness Score
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
RWIS	Road Weather Information System
SR	State Route
TI	Traffic Interchange
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTTI	Truck Travel Time Index
UP	Underpass
US	U.S. Route
VMT	Vehicle Miles Travelled
VSL	Variable Speed Limit
V/C	Volume to Capacity Ratio
WB	Westbound

1 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this corridor profile study of the western section of Interstate 40 (I-40) between the California State Line and Interstate 17 (I-17). This study will look at key performance measures relative to the I-40 West corridor, and use those as a means to prioritize future improvement in areas that show critical needs.

The intent of the corridor profile program, and of the Planning to Programming process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network. ADOT is conducting eleven corridor profile studies. The eleven corridors are being evaluated within three separate groupings.

The first three studies (Round 1) began in spring 2014, and encompass:

- I-17: SR 101L to I-40
- I-19: Mexico International Border to I-10
- I-40 West: California State Line to I-17

The second round (Round 2) of studies, initiated in spring 2015, includes:

- I-8: California State Line to I-10
- I-40 East: I-17 to the New Mexico State Line
- SR 95: I-8 to I-40

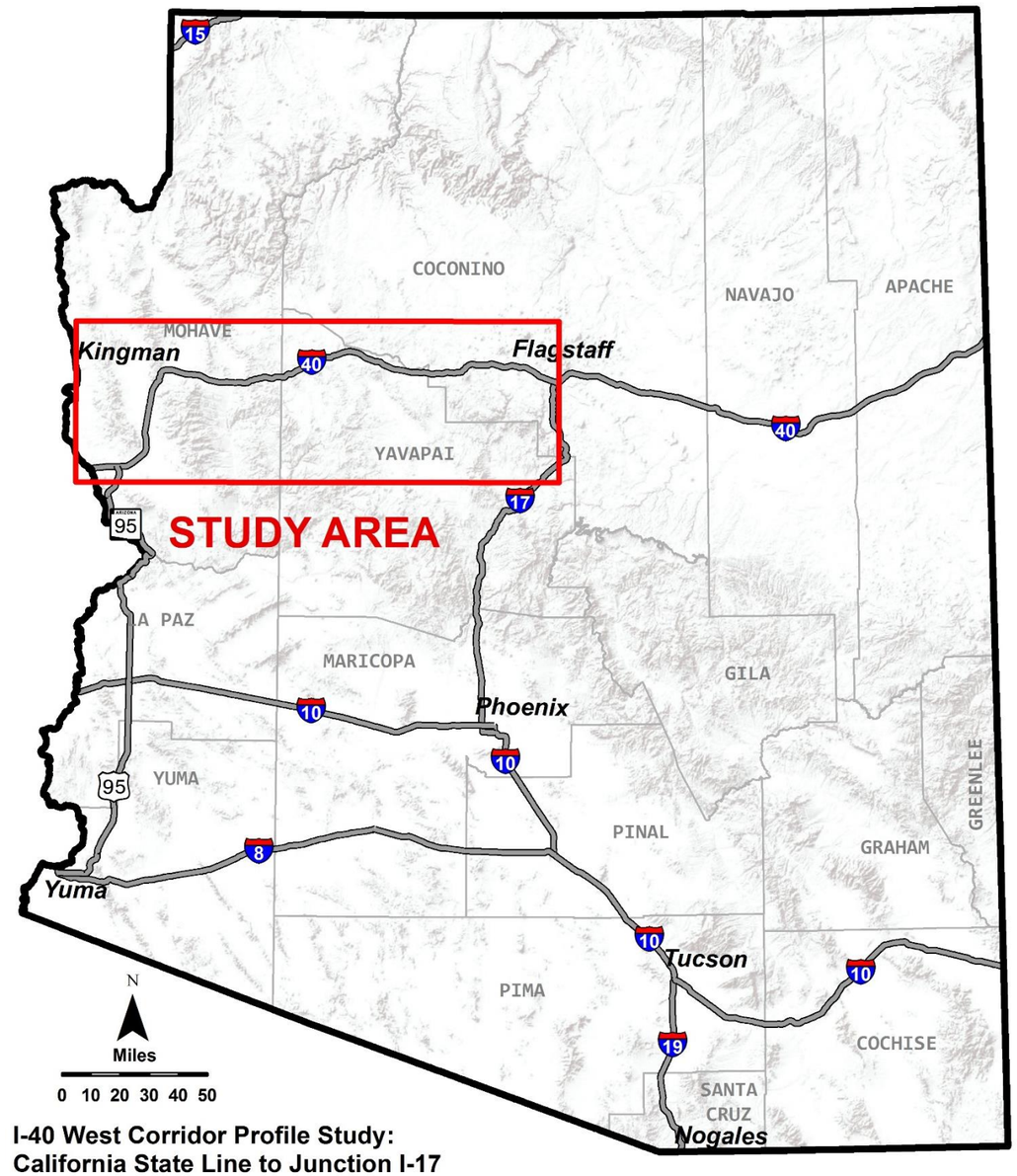
The third round (Round 3) of studies, initiated in fall 2015, include:

- I-10 West: California State Line to SR 85 and SR 85: I-10 to I-8
- I-10 East: SR 202L to the New Mexico State Line
- SR 87/SR 260/SR 377: SR 202L to I-40
- US 60/US 70: SR 79 to US 191 and US 191: US 70 to SR 80
- US 60/US 93: Nevada State Line to SR 303L

The studies under this program will assess the overall health, or performance, of the state' strategic highways. The Corridor Profile Studies will identify candidate projects for consideration in the Multimodal Planning Division's (MPD) Planning to Programming (P2P) project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

I-40, California State Line to I-17, shown in **Figure 1**, is one of the strategic statewide corridors and the subject of this Round 1 Corridor Profile Study.

Figure 1: Study Location Map



I-40 West Corridor Profile Study:
California State Line to Junction I-17
Study Area Context

1.1 Corridor Study Purpose

The purpose of the I-40 West Corridor Profile Study is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished through the following process:

- Inventory past improvement recommendations
- Assess the existing performance based on quantifiable performance measures
- Define goals and objectives for the future of the corridor
- Propose various solutions to improve corridor performance
- Identify specific projects that can provide quantifiable benefits in relation to the performance measures
- Prioritize the projects for future implementation

1.2 Corridor Study Goals and Objectives

The objective of this study is to identify a recommended set of potential projects for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-40 West Corridor Profile Study will define solutions and improvements for the corridor that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals have been identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

1.3 Working Paper 6 Overview

The objective of Working Paper 6 is to document the evaluation of the strategic solutions (projects) identified for the I-40 West corridor. This evaluation will include a Life-Cycle Cost Analysis (LCCA) for pavement and bridge projects and a Benefit-Cost Analysis (BCA) on freight, safety, and mobility projects that have multiple options. In addition, this evaluation will also include a risk-based performance effectiveness evaluation on each recommendation to determine the amount of benefit to the performance scores each project produces. The result of this evaluation will be a prioritized list of recommendations for the I-40 West corridor.

1.4 Corridor Overview

Interstate 40 (I-40) from the California State Line to Junction Interstate 17 (I-17) is and will continue to be a major transportation corridor for intrastate, interstate, regional, and local traffic and commerce in Arizona. I-40 is designated by ADOT as a strategic highway corridor and has been identified as playing a key role in the overall performance of the statewide transportation system. The I-40 West corridor connects the cities of Kingman, Williams, and Flagstaff as well as unincorporated communities such as Topock, Yucca, Seligman, Ash Fork, Parks, and Bellemont.

1.5 Study Location and Corridor Segments

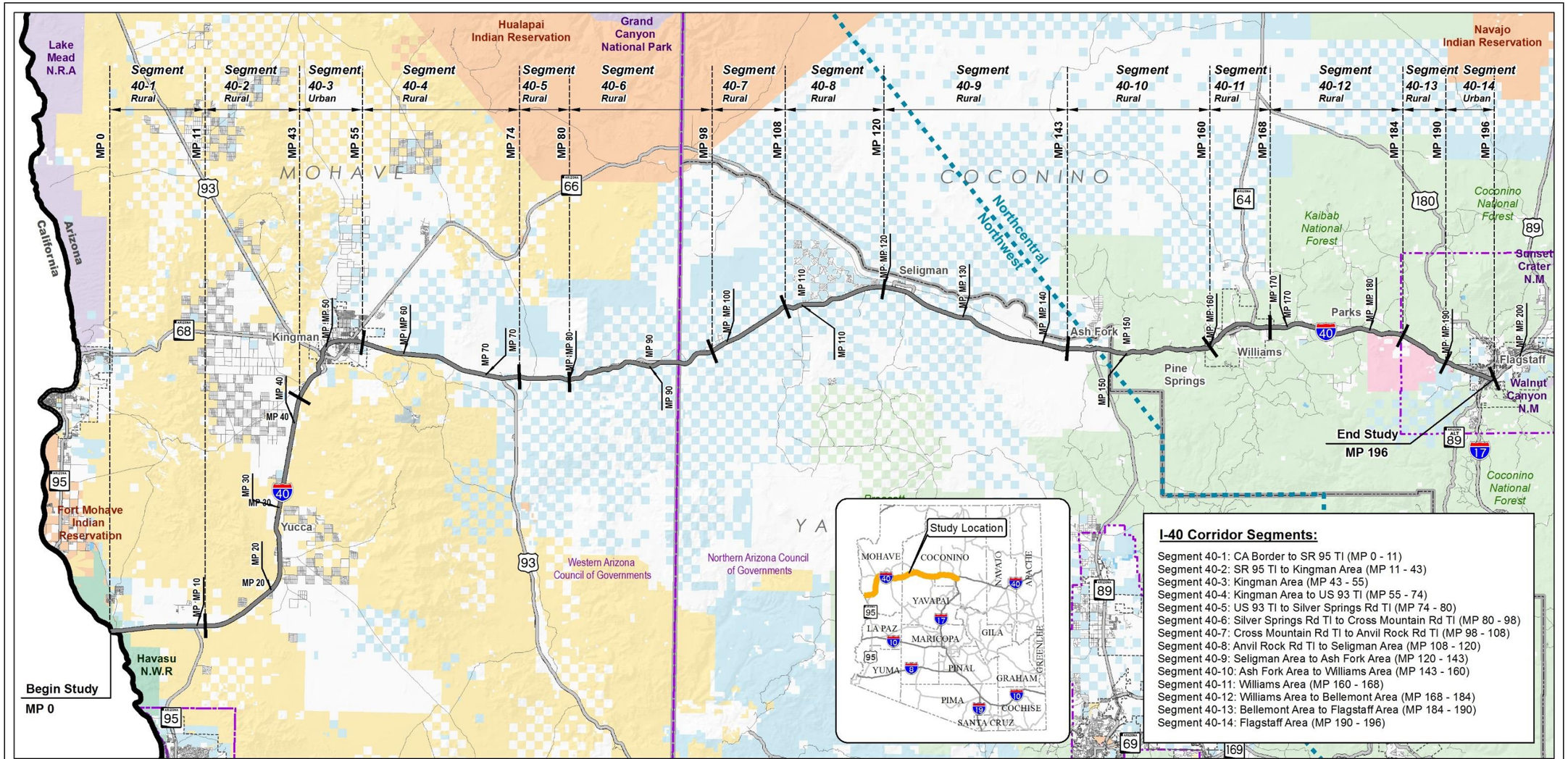
The I-40 West corridor is a 196-mile freeway corridor located in western Arizona that serves interstate, regional, and local traffic and commerce demands between the ports of California and destinations east. The corridor study limits extend from milepost 0 at the California state line to milepost 196 in Flagstaff, east of the I-40/I-17 freeway interchange, as illustrated in **Figure 2.**

The I-40 West corridor has been divided into fourteen planning segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. Planning segments for the I-40 West corridor are defined in **Table 1** and shown in **Figure 2.**

Table 1: Corridor Segmentation

Segment Number	Begin Milepost	End Milepost	Length (miles)	Description of Segment Features
40-1	0	11	11	Topock, State Route (SR) 95, Lake Havasu
40-2	11	43	32	Yucca, Chrysler Arizona Proving Ground
40-3	43	55	12	Kingman, US 93
40-4	55	74	19	Blake Ranch, I-40/US 93
40-5	74	80	6	Silver Springs
40-6	80	98	18	Willow Creek
40-7	98	108	10	Jolly Rd
40-8	108	120	12	Anvil Rock
40-9	120	143	23	Seligman, Route 66
40-10	143	160	17	Ash Fork, SR 89, Pine Springs
40-11	160	168	8	Williams, SR 64
40-12	168	184	16	Parks
40-13	184	190	6	Bellemont
40-14	190	196	6	West Flagstaff

Figure 2: Project Vicinity/Segmentation Map



I-40 Corridor Study: MP 0 to MP 196
Project Vicinity and Segmentation

2 CANDIDATE SOLUTION EVALUATION PROCESS

Candidate Solutions identified in Working Paper 5 will be evaluated in multiple ways including a Life-Cycle Cost or Benefit-Cost Analysis (where applicable), Risk Analysis, and a Performance Effectiveness Analysis. The methodology and approach to this analysis is described below. **Figure 3** illustrates the candidate solution evaluation process.

2.1 Life-Cycle Cost Analysis or Benefit-Cost Analysis

All pavement and bridge candidate solutions have multiple options: rehabilitate the area of need, or fully reconstruct the issue area or structure. These options will be evaluated through a life-cycle cost analysis (LCCA) to determine the best approach for each location where a pavement or bridge solution is recommended. The LCCA could eliminate options from further consideration and will identify which options should be carried forward for further evaluation.

Any mobility, safety, or freight strategic issue area that resulted in multiple independent candidate solutions will be evaluated through a benefit-cost analysis (BCA) to determine which solutions should be eliminated or carried forward. Multiple solution options are typically only developed for large-scale improvements with significant differences in scope, complexity, or cost. After the LCCA and BCA, the remaining options will be advanced to the Performance Effectiveness Evaluation.

2.2 Performance Effectiveness Evaluation

After the LCCA and BCA processes are complete, all remaining candidate solutions will be evaluated based on their performance effectiveness. This process will include determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing Performance and Needs scores for each project segment. This evaluation will also include a Performance Area Risk Evaluation to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

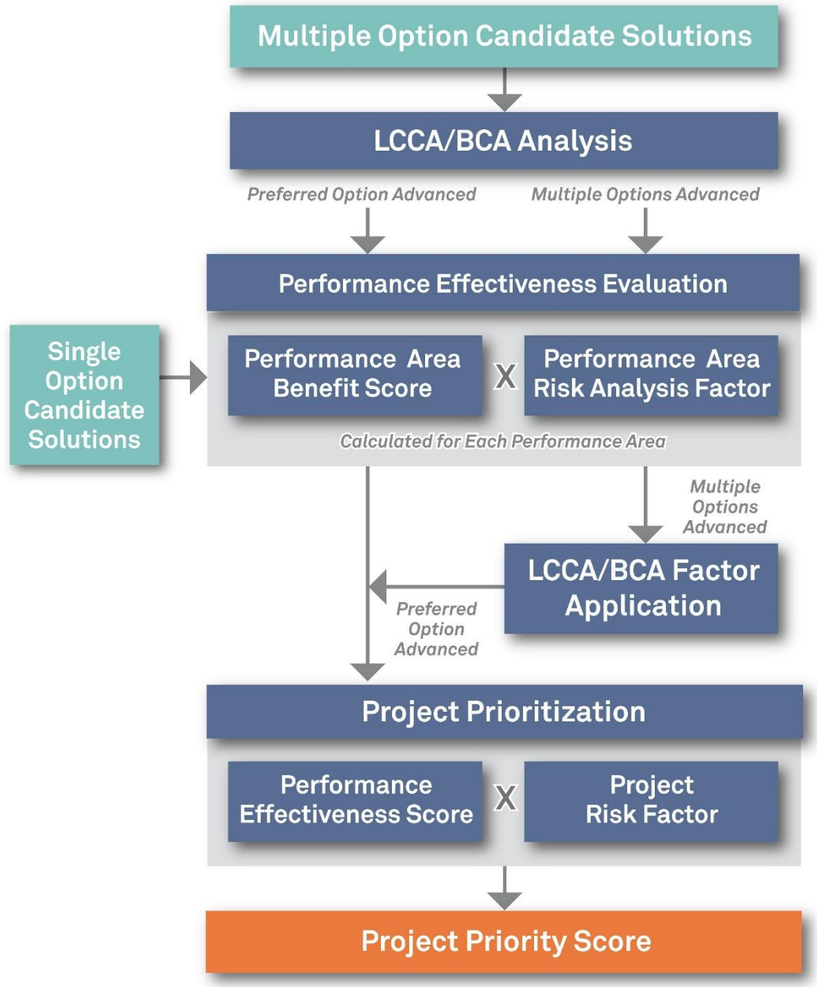
2.3 Risk Analysis

All candidate solutions that are advanced through the Performance Effectiveness Evaluation will also be evaluated through a Risk Analysis process. This process will examine the risk of not implementing a recommended solution in terms of overall corridor performance. The results of this analysis will be combined with the Performance Effectiveness scores to determine the highest priority solutions in the corridor.

The highest ranking solutions will become recommended strategic investments and will be compared to other projects nominated through the ADOT P2P process.

Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and consultants develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT programming process.

Figure 3: Solution Evaluation Process



3 CANDIDATE SOLUTION EVALUATION

The principal objective of the corridor profile study is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. The corridor profile process is intended to provide input to the P2P process and will assign strategic solutions to one of the three investment categories: Preservation, Modernization, or Expansion.

The performance system and performance needs previously documented in Working Papers 2 and 4, respectively, served as a foundation for developing strategic solutions for corridor preservation, modernization, and expansion.

Strategic solutions are not intended to recreate or replace results from normal programming processes. However, they should address elevated levels (high or medium) of need and focus on investments in Modernization projects to optimize current infrastructure. Ideally, strategic solutions should address overlapping needs and reduce costly repetitive maintenance. In addition, they should provide a measureable benefit (benefit/cost ratio, risk, LCCA, performance system, etc.)

Strategic solutions were derived from previous reports, field reviews, ADOT staff input, observable trends in the performance data, current standards, national and local best practices, and engineering judgement. **Table 2** contains the candidate strategic solutions for the corridor. **Appendix A** contains a Candidate Solution Cost Estimates table showing the derivation of total cost for each candidate solution.

Following the distribution of Draft Working Paper 5 (Strategic Solutions), several modifications were made to the Performance System (Draft Working Paper 2) due to input from the Round 2 and Round 3 corridor profile studies. These modifications resulted in revisions to the Needs Assessment (Draft Working Paper 4) and the resulting Strategic Solutions (Draft Working Paper 5). Therefore, the candidate solutions shown in **Table 2** differ slightly from those shown in Draft Working Paper 5.

Table 2: Candidate Solutions

Candidate #	Name	Begin MP	End MP	Option *	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS 40.1	Colorado River Bridge #957	0	0	-	Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement	M
CS 40.2	Topock Area Pavement Improvements	3	8	A	Rehabilitate pavement	P
				B	Replace pavement	M
CS 40.3	Stateline to SR-95 Safety Improvements	0	11	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers	M
CS 40.4	Franconia Wash WB Bridge #377	13	13	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.5	Illavar Wash EB Bridge #1310	18	18	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.6	Flat Top Wash WB Bridge #1312	21	21	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.7	Griffith Wash WB Bridge #369	40	40	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.8	SR-95 to Kingman Safety Improvements	11	43	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Provide driver information (advance notice of Rest Area)	M
CS 40.9	Kingman Area Safety and Mobility Improvements	43	55	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Install median cable barrier at MP 47-51; Construct climbing lane EB at MP	M

** '– ' indicates only one solution is being proposed so there are no Option A and Option B for this solution*

Candidate #	Name	Begin MP	End MP	Option *	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
					47-51; Implement Variable Speed Limits (VSL) at MP 47-53 EB/WB and integrate with existing Dynamic Message Sign (DMS) at MP 45 (EB) and MP 55 (WB) to provide driver information	
CS 40.10	Kingman to US 93 Safety Improvements	55	74	-	Construct climbing lane EB at MP 58-60; Install VSL at MP 58-71 EB/WB and integrate with existing DMS at MP 69 (EB) and with new DMS at MP 55 (EB) and MP 72 (WB) to provide driver information	M
CS 40.11	Willow Creek Safety Improvements	80	98	-	Construct climbing lane EB at MP 80-83 and MP 93-97; Implement VSL at MP 80-83 EB, MP 88-90 EB, and MP 93-97 EB and integrate with existing Road Weather Information System (RWIS) at MP 91 and new DMS at MP 79 (EB) and MP 98 (WB) to provide driver information	M
CS 40.12	Jolly Road Area Safety Improvements	98	108	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Implement VSL at MP 101-104 EB/WB and integrate with new RWIS at MP 103 and new DMS at MP 100 (EB) and MP 105 (WB)	M
CS 40.13	Anvil Rock Rd TI UP Bridge #1610	110	110	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.14	Johnson Canyon WB Bridge #441	148	148	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.15	Ash Fork to Williams Safety Improvements	143	160	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Construct climbing lane EB at MP 151-152 and MP 156-159; Implement VSL at MP 151-159 EB/WB and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at MP 144 (EB) and with new DMS at MP 160 (WB)	M
CS 40.16	Williams Area Safety Improvements	160	168	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers; Construct climbing lane WB at MP 162-163; Implement VSL at MP 161-163 EB/WB and integrate with existing RWIS at MP 159 and existing DMS at MP 168 (WB) and with new DMS at MP 160 (EB)	M
CS 40.17	West Flagstaff Pavement Improvements	191	196	A	Rehabilitate pavement	P
				B	Replace pavement	M
CS 40.18	W Flagstaff TI EB Bridge #1128	192	192	A	Rehabilitate bridge - re-evaluate Fiscal Year (FY) 2019 deck rehab project	P
				B	Replace bridge - re-evaluate FY 2019 deck rehab project	M
CS 40.19	Flag Ranch TI EB Bridge #2027	193	193	A	Rehabilitate bridge	P
				B	Replace bridge	M
CS 40.20	Woody Mountain Road TI WB Bridge #1133	194	194	A	Rehabilitate bridge	P
				B	Replace bridge	M

** '– ' indicates only one solution is being proposed so there are no Option A and Option B for this solution*

3.1 Life-Cycle Cost Analysis and Benefit-Cost Analysis

A life-cycle cost analysis (LCCA) or benefit-cost analysis (BCA) was conducted for any candidate solutions that contain multiple options. The intent of the LCCA and BCA was to determine which options warrant further investigation and eliminate options that would not be considered strategic. An LCCA was performed on Pavement and Bridge candidate solutions while a BCA was performed on Mobility, Safety, or Freight candidate solutions (where required).

Life-Cycle Cost Analysis

Life-Cycle Cost Analysis is an economic analysis that compares cost streams over time and presents the results in a common measure, the present value of all future costs. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For both bridge and pavement LCCA, the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping the bridge or pavement serviceable over a long period of time.

LCCA is performed to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short-term costs that often dominate the considerations in transportation investment decision-making and programming.

For the bridge LCCA, three basic strategies were analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Bridge replacement (large upfront cost but small ongoing costs afterwards)
- Bridge rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- On-going repairs until replacement (low upfront and ongoing costs until replacement)

The bridge LCCA model developed for the Corridor Profile Studies reviews the characteristics of the candidate bridges including bridge ratings and deterioration rates to develop the three improvement strategies (full replacement, rehabilitation until replacement, and repair until replacement). Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length-to-span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance. The following assumptions are included in the bridge LCCA model:

- The bridge LCCA will only address the structural condition of the bridge and will not address other issues or costs
- The bridge will require replacement near the end of the its 75-year service life regardless of current condition
- The bridge elevation, pier height, skew angle, and length-to-span ratio can affect the replacement and rehabilitation costs
- The current and historical ratings were used to estimate a rate of deterioration for each candidate bridge
- Following bridge replacement, repairs will be needed every 20 years
- Different bridge repair and rehabilitation strategies have different costs, expected service life, and benefit to the bridge rating
- The net present value of future costs will be discounted at 3%
- If the LCCA evaluation recommends rehabilitation or repair, the project will not be considered strategic and the rehabilitation or repair will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% of each other should be considered equally. In such a case, the project should be carried forward as a strategic replacement project – more detailed scooping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 2**, LCCA was conducted on nine bridges on the I-40 West corridor. A summary of this analysis is shown in **Table 3.** Additional information regarding the bridge LCCA is contained in **Appendix B**.

For the pavement LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected pavement, as described below:

- Pavement replacement (large upfront cost but small ongoing costs afterwards)
- Pavement major rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- Pavement minor rehabilitation until replacement (low upfront and ongoing costs until replacement)

The pavement LCCA model developed for the Corridor Profile Studies reviews the characteristics of the candidate paving locations including the historical rehabilitation frequency to develop potential improvement strategies (full replacement, major rehabilitation until replacement, and minor rehabilitation until replacement, for either concrete or asphalt, as applicable). Each strategy consists of a set of corrective actions that contribute to keeping the pavement serviceable over the analysis period. Cost and effect of these improvement actions on the pavement condition are essential parts of the model. The following assumptions are included in the pavement LCCA model:

- The pavement LCCA will only address the condition of the pavement and will not address other issues or costs
- The historical pavement rehabilitation frequencies at each location were used to estimate the future rehabilitation frequencies
- Different pavement replacement and rehabilitation strategies have different costs and expected service life
- The net present value of future costs will be discounted at 3%
- If the LCCA evaluation recommends major or minor rehabilitation, the project will not be considered strategic and the rehabilitation will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% of each

other should be considered equally. In such a case, the project should be carried forward as a strategic replacement project - more detailed scoping will confirm if replacement or rehabilitation is needed.

Based on the candidate solutions presented in **Table 2**, LCCA was conducted for two pavement projects on the I-40 West corridor. A summary of this analysis is shown in **Table 4.** Additional information regarding the pavement LCCA is contained in **Appendix B.**

As shown in **Table 3** and **Table 4**, the following conclusions were determined based on the LCCA:

- Rehabilitation or repair was determined to be the most effective approach for the candidate solutions listed below and these locations do not have other Needs. Therefore, it is assumed that these will be addressed by normal programming processes and these candidate solutions will be dropped from further consideration.
    - Johnson Canyon WB Bridge #441 (CS 40.14)
    - West Flagstaff TI EB Bridge #1128 (CS 40.18)
    - Flag Ranch TI EB Bridge #2027 (CS 40.19)
    - Woody Mountain Road TI WB Bridge #1133 (CS 40.20)
- Replacement was determined to be the most effective approach for the candidate solutions listed below so these will be carried forward for further consideration.
    - Topock Area Pavement Improvements MP 3-8 (CS 40.2)
    - Franconia Wash WB Bridge #377 (CS 40.4)
    - Illavar Wash EB Bridge #1310 (CS 40.5)
    - Flat Top Wash WB Bridge #1312 (CS 40.6)
    - Griffith Wash WB Bridge #1658 (CS 40.7)
    - Anvil Rock Road TI UP Bridge #1610 (CS 40.13)
    - West Flagstaff Area Pavement Improvements MP 191-196 (CS 40.17)

Benefit-Cost Analysis

The I-40 West corridor did not include any candidate solutions with multiple options for Mobility, Safety, or Freight performance areas so no benefit-cost analysis was conducted.

Table 3: Bridge LCCA Results

Bridge	Present Value at 3% ($)			Ratios of Present Value to Lowest Cost (%)			Comments
	Replace	Rehab	Repair	Replace	Rehab	Repair	
Anvil Rock TI UP #1610	**$2,134,385**	$2,611,217	$2,264,683	1.00	1.22	1.06	Strategic project – Replacement is lowest cost and is recommended
Flag Ranch TI EB #2027	$2,054,310	$1,776,952	**$1,411,826**	1.46	1.26	1.00	Not strategic project alone
Flat Top Wash WB #1312	$2,636,158	**$2,273,973**	$2,368,572	1.16	1.00	1.04	Service life complete by 2030 – Replacement is recommended
Franconia Wash WB #377	$2,408,133	**$2,077,277**	$2,185,083	1.16	1.00	1.05	Service life complete by 2030 – Replacement is recommended
Griffith Wash WB #1658	$2,218,987	**$2,030,688**	$2,134,809	1.09	1.00	1.05	Service life complete by 2030 and Replacement is within 15% of lowest cost – Replacement is recommended
Illavar Wash EB #1310	$2,388,191	**$2,185,533**	$2,289,655	1.09	1.00	1.05	Service life complete by 2030 and Replacement is within 15% of lowest cost – Replacement is recommended
Johnson Canyon WB #441	$953,265	$1,179,843	**$789,796**	1.21	1.49	1.00	Not strategic project alone
West Flagstaff TI EB #1128	$1,987,716	$1,695,824	**$1,299,149**	1.53	1.31	1.00	Not strategic project alone
Woody Mountain Road TI WB #1133	$2,054,310	$1,729,508	**$1,298,712**	1.58	1.33	1.00	Not strategic project alone

Table 4: Pavement LCCA Results

Pavement	Present Value at 3% ($)				Ratios of Present Value to Lowest Cost (%)				Comments
	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation	
Topock Area Pavement Improvements (MP 3-8)	$53,350,002	$60,304,011	**$50,540,831**	$54,955,186	1.06	1.19	1.00	1.09	Concrete Reconstruction is within 15% of lowest cost – Replacement is recommended
West Flagstaff Area Pavement Improvements (MP 191-196)	$67,190,280	$68,880,312	**$64,332,024**	$64,390,288	1.04	1.07	1.00	1.00	Concrete and Asphalt Reconstruction are within 15% of lowest cost – Replacement is recommended

3.2 Performance Effectiveness Evaluation

After the LCCA and BCA processes were complete, all remaining candidate solutions were evaluated based on their performance effectiveness. This process included determining a performance effectiveness score based on how much each solution impacts the existing Performance and level of Need scores for each project segment. The results of this evaluation will be combined with the results of a risk analysis to determine a Performance Effectiveness Score. The objectives of the Performance Effectiveness Evaluation include:

- Measure of benefit in performance system versus cost of solution
- Include risk factors to help differentiate between similar solutions
- Applicable to each Performance Area that is affected by the candidate solution
- Accounts for Emphasis Areas that were identified for the corridor

The Performance Effectiveness Evaluation includes the following steps:

- Estimate the post-project performance for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight)
- Use the post-project performance scores to calculate a post-project level of Need for each of the five performance areas
- Compare the pre-project level of Need to the post-project level of Need to determine the reduction in level of Need (potential project benefit) for each of the five performance areas
- Calculate performance area risk weighting factors for each of the five performance areas
- Using the reduction in level of Need (benefit) and risk weighting factors, calculate the Performance Effectiveness Score

For each Performance Area, a slightly different approach was used to estimate the post-project performance. This process was based on the following assumptions:

- Pavement:
  - The International Roughness Index (IRI) rating would decrease (to 30 for replacement or 45 for rehabilitation)
  - The Cracking rating would decrease (to 0 for replacement or rehabilitation)
- Bridge:
  - The structural ratings would increase (+1 for repair, +2 for rehabilitation, or increase to 8 for replacement)
  - The bridge sufficiency rating would increase (+10 for repair, +20 for rehabilitation, or increase to 98 for replacement)
- Mobility:
  - Additional lanes would increase the capacity and therefore revise the Mobility Index and associated secondary measures
  - Other improvements (ramp metering, parallel ramps, variable speed limits) will also increase the capacity (to a lesser extent than additional lanes) and therefore revise the Mobility Index and associated secondary measures
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the Travel Time Index (TTI) secondary measure
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Planning Time Index (PTI) secondary measure
  - Changes in the Safety Index (due to crash reductions) would have direct effect on the Closure Extent secondary measure
- Safety:
  - Crash Modification Factors were developed and applied to estimate the reduction in crashes (see **Appendix C**)
- Freight:
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Freight Index and the Truck PTI (TPTI) secondary measure
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the Truck TTI (TTTI) secondary measure
  - Changes in the Safety Index (due to crash reductions) would have direct effect on the Closure Duration secondary measure

The Performance Area Risk Assessment is intended to develop a numeric risk weighting factor for each of the five Performance Areas. This risk assessment addresses other considerations for each Performance Area that are not directly included in the Performance System. A risk weighting factor is calculated for each candidate solution based on the specific characteristics at the project location. For example, the Pavement Risk Factor is based on factors such as the elevation, daily traffic volumes, and amount of truck traffic. Additional information regarding the Performance Area Risk Assessment is included in **Appendix D**.

Following the calculation of the reduction in level of Need (benefit) and the Performance Area Risk Factors, these values were used to calculate the Performance Effectiveness Score (PES). In addition, the reduction in level of Need in each Emphasis Area was also included in the PES. The PES can be described as follows:

PES = (Sum of all Risk Factored Benefit Scores + Sum of all Risk Factored Emphasis Area Scores) x 100 / Cost x VMT / 10,000

Where,

Risk Factored Benefit Score = Reduction in Segment-Level Need (benefit) x Performance Area Risk Weighting Factor (calculated for each Performance Area)

Risk Factored Emphasis Area Score = Reduction in Corridor-Level Need x Performance Area Risk Factors x Emphasis Area Factor (calculated for each Emphasis Area)

Cost = estimated cost of candidate solution in $ millions

VMT = vehicle miles travelled at location of candidate solution based on current (2014) daily volume and length of project

The resulting PES values are shown in **Table 5**. Additional information regarding the Performance Effectiveness Scoring is included in **Appendix E**.

Table 5: Initial Performance Effectiveness Scores

Candidate Solution #	Name	Milepost Location	Estimated Cost ($ million)	Risk Factored Benefit Score					Risk Factored Emphasis Area Scores			Total Factored Benefit Score	VMT/10,000	Performance Effectiveness Score
				Pavement	Bridge	Safety	Mobility	Freight	Pavement	Bridge	Safety			
CS 40.1	Colorado River Bridge #957	0-0	55.0	-	10.61	-	0.43	0.06	-	15.91	-	27.02	0.32	15.7
CS 40.2	Topock Area Pavement Improvements Option B - Replacement	3-8	42.9	0.16	-	2.02	0.96	0.09	0.24	-	1.60	5.07	6.51	76.9
CS 40.3	Stateline to SR-95 Safety Improvements	0-11	6.1	-	-	5.97	1.21	0.08	-	-	8.95	16.22	14.33	3,809.5
CS 40.4	Franconia Wash WB Bridge #377 Option B - Replacement	13-13	2.3	-	0.44	-	0.02	0.02	-	0.66	-	1.15	0.02	1.1
CS 40.5	Illavar Wash EB Bridge #1310 Option B - Replacement	18-18	1.2	-	0.29	-	0.02	0.02	-	0.44	-	0.77	0.01	0.7
CS 40.6	Flat Top Wash WB Bridge #1312 Option B - Replacement	21-21	2.0	-	0.39	-	0.02	0.02	-	0.58	-	1.01	0.02	0.9
CS 40.7	Griffith Wash WB Bridge #369 Option B - Replacement	40-40	2.0	-	0.50	-	0.02	0.02	-	0.75	-	1.29	0.02	1.1
CS 40.8	SR-95 to Kingman Safety Improvements	11-43	18.1	-	-	2.39	0.18	0.06	-	-	3.58	6.22	43.12	1,480.8
CS 40.9	Kingman Area Safety and Mobility Improvements	43-55	37.8	-	-	7.08	0.28	2.08	-	-	10.62	20.06	25.19	1,336.9
CS 40.10	Kingman to US 93 Safety Improvements	55-74	19.5	-	-	0.59	0.03	3.67	-	-	1.53	5.82	32.60	972.7
CS 40.11	Willow Creek Safety Improvements	80-98	44.9	-	-	0.69	1.10	1.26	-	-	1.14	4.19	10.69	99.7
CS 40.12	Jolly Road Area Safety Improvements	98-108	9.5	-	-	2.35	0.38	0.68	-	-	3.52	6.93	12.89	941.1
CS 40.13	Anvil Rock Rd TI UP Bridge # 1610 Option B - Replacement	110-110	2.3	-	3.01	-	0.04	0.04	-	4.51	-	7.60	0.06	21.6
CS 40.15	Ash Fork to Williams Safety Improvements	143-160	40.1	-	-	6.07	4.60	7.72	-	-	9.11	27.50	24.41	1,673.6
CS 40.16	Williams Area Safety Improvements	160-168	13.7	-	-	0.93	0.02	0.31	-	-	1.40	2.66	12.62	244.6
CS 40.17	West Flagstaff Pavement Improvements Option B - Replacement	191-196	42.9	2.13	-	0.02	0.14	0.06	3.20	-	0.03	5.58	13.71	178.4

4 CANDIDATE SOLUTION PRIORITIZATION

Following the calculation of the Performance Effectiveness Scores (PES), an additional step was taken to develop the prioritized list of projects. A risk probability and consequence analysis was conducted to develop a project-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure. **Figure 4** shows the risk matrix that was used to develop the risk weighting factors.

Figure 4: Risk Matrix

		Severity/Consequence				
		Insignificant	**Minor**	**Significant**	**Major**	**Catastrophic**
Frequency/Likelihood	**Very Rare**	Low	Low	Low	Moderate	Major
	Rare	Low	Low	Moderate	Major	Major
	Seldom	Low	Moderate	Moderate	Major	Severe
	Common	Moderate	Moderate	Major	Severe	Severe
	Frequent	Moderate	Major	Severe	Severe	Severe

Using the risk matrix in **Figure 4**, numeric values were assigned to each category of frequency and severity. The higher the risk, the higher the numeric factor that was assigned. The risk weight for each area of the matrix was calculated by multiplying the severity factor times the frequency factor. These numeric factors are shown in **Figure 5.**

Figure 5: Numeric Risk Matrix

			Severity/Consequence				
			Insignificant	**Minor**	**Significant**	**Major**	**Catastrophic**
		Weight	1.00	1.05	1.10	1.15	1.20
Frequency/Likelihood	**Very Rare**	1.00	1.00	1.05	1.10	1.15	1.20
	Rare	1.05	1.05	1.10	1.16	1.21	1.26
	Seldom	1.10	1.10	1.16	1.21	1.27	1.32
	Common	1.15	1.15	1.21	1.27	1.32	1.38
	Frequent	1.20	1.20	1.26	1.32	1.38	1.44

Using the values in **Figure 5**, risk weighting factors were calculated for each of the following four risk categories: low, moderate, major, and severe. These values are simply the average of the values in **Figure 5** that fall within each category. The resulting average risk weighting factors are:

Low	Moderate	Major	Severe
1.07	1.18	1.24	1.36

The risk weighting factors listed above were assigned to the five performance areas as follows:

- Safety = 1.36
  - The Safety performance area quantifies the likelihood of fatal or incapacitating crashes; therefore, it was assigned the Severe (1.36) risk weighting factor.
- Bridge = 1.24
  - The Bridge performance area focuses on the structural adequacy of the bridges. A failure may result in crashes or traffic being detoured for long periods of time resulting in significant travel time increases; therefore, it was assigned the Major (1.24) risk weighting factor.
- Mobility and Freight = 1.18
  - The Mobility and Freight performance areas focus on capacity and congestion. Failure in either of these performance areas would result in increased travel times but would not have significant effect on safety (crashes) that would not already be addressed in the Safety performance area; therefore, they were assigned the Moderate (1.18) risk weighing factor.
- Pavement = 1.07
  - The Pavement performance area focuses on the ride quality of the pavement. Failure in this performance area would likely be a spot location that would not dramatically affect drivers beyond what is already captured in the Safety performance area.

The benefit in each performance area was calculated for each candidate solution as part of the Performance Effectiveness Evaluation. Using this information, and the risk factors listed above, a weighted (based on benefit) project-level numeric risk factor was calculated for each candidate solution. For example, a solution that has 50% of its benefit in Safety and 50% of its benefit in Mobility would have a risk factor of 1.27 (0.50 x 1.18 + 0.50 x 1.36 = 1.27). **Appendix F** contains the Project Prioritization Scores, including risk factors associated with each project and performance area. These risk factors were applied directly to the Performance Effectiveness Scores shown in **Table 6**. Candidate Solutions were prioritized based on these results, as shown in **Table 6**.

Table 6: Prioritized Project List

Rank	Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ million)	Performance Effectiveness Score	Risk Factor	Prioritization Score
1	CS 40.3	Stateline to SR-95 Safety Improvements	0-11	6.1	3809.5	1.35	5126.2
2	CS 40.15	Ash Fork to Williams Safety Improvements	143-160	40.1	1673.6	1.28	2141.2
3	CS 40.8	SR-95 to Kingman Safety Improvements	11-43	18.1	1481.8	1.35	2004.6
4	CS 40.9	Kingman Area Safety and Mobility Improvements	43-55	37.8	1336.9	1.34	1789.8
5	CS 40.12	Jolly Road Area Safety Improvements	98-108	9.5	941.1	1.33	1253.9
6	CS 40.10	Kingman to US 93 Safety Improvements	55-74	19.5	972.7	1.25	1211.6
7	CS 40.16	Williams Area Safety Improvements	160-168	13.7	244.6	1.34	327.3
8	CS 40.17	West Flagstaff Pavement Improvements Option B - Replacement	191-196	42.9	178.4	1.08	192.0
9	CS 40.11	Willow Creek Safety Improvements	80-98	44.9	99.7	1.26	125.5
10	CS 40.2	Topock Area Pavement Improvements Option B - Replacement	3-8	42.9	76.9	1.30	100.0
11	CS 40.13	Anvil Rock Rd TI UP Bridge # 1610 Option B - Replacement	110-110	2.3	21.6	1.27	27.4
12	CS 40.1	Colorado River Bridge #957	0-0	55.0	15.7	1.27	19.9
13	CS 40.7	Griffith Wash WB Bridge #369 Option B - Replacement	40-40	2.0	1.1	1.27	1.4
14	CS 40.4	Franconia Wash WB Bridge #377 Option B - Replacement	13-13	2.3	1.1	1.27	1.3
15	CS 40.6	Flat Top Wash WB Bridge #1312 Option B - Replacement	21-21	2.0	0.9	1.27	1.1
16	CS 40.5	Illavar Wash EB Bridge #1310 Option B - Replacement	18-18	1.2	0.7	1.27	0.9

Table 6 prioritizes the strategic solutions recommended as a result of this corridor profile study. These solutions will increase the performance of the I-40 West corridor across a majority of the performance areas. Solutions that address multiple performance areas tend to score higher in this process. Several projects on the corridor scored high on the Performance Effectiveness Scale due to overlapping benefits in different performance areas, including the following:

- Segment 1 resulted in the highest Needs Score for the corridor, due to high needs in Safety and Bridge along with other needs in Pavement, Mobility and Freight. The first ranked project (CS 40.3) would enhance safety and may also help improve other performance areas such as Freight and Mobility, thus resulting in benefits across multiple performance areas.
- Segment 10 resulted in high needs in both Safety and Freight performance areas. The second ranked project (CS 40.15) will address both of these performance areas through the recommended improvements, thus resulting in benefits across multiple performance areas.
- Several of the top scoring projects include safety improvements at specific locations that would likely reduce the incidence of run-off-the-road type vehicle crashes that often result in fatal and serious injuries.

5 NEXT STEPS

The aforementioned prioritized project list of strategic investments for the I-40 West corridor should be nominated for consideration in the ADOT statewide P2P process along with other project nominations from other ADOT processes. Strategic investments recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety and Freight.

The findings and recommendations from the I-40 West Corridor Profile Study will be documented in a Final Report. This document will summarize all prior working papers, incorporating updates made throughout the study process in response to input received from stakeholders and process refinements recommended by the Round 2 and Round 3 corridor profile studies.

The findings and recommendations from the I-40 West Corridor Profile Study will also be combined with the findings and recommendations from the other Round 1, Round 2, and Round 3 corridor profile studies into a statewide report on the corridor profile studies once all three rounds are complete. This statewide report will allow for comparison between corridors and will include statewide mapping of performance scores and levels of need.

Appendix A Candidate Solution Cost Estimates

Candidate Solution Costs														
Candidate #	Location #	Name	Beginning MP	Ending MP	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Square Footage	Unit Cost	Preliminary Engineering (3% of Construction)	Design (10% of Construction)	Right-of-Way (assuming $12 per square foot)	Construction	Total Cost
CS 40.1	L2	Colorado River Bridge	0	0	-	Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement	M	80228	$280	$0	$0	$0	$55,000,000	$55,000,000
CS 40.2	L1	Topock Area Pavement Improvements	3	8	A	Rehabilitate pavement	P	-	$590,000	$180,000	$590,000	$0	$5,900,000	$6,670,000
					B	Replace pavement and subgrade	M	-	$3,810,000	$1,100,000	$3,800,000	$0	$38,000,000	$42,900,000
CS 40.3	L3	Stateline to SR-95 Safety Improvements	0	11	-	Rehabilitate shoulder and re-install rumble strips; Install high-visibility delineators and raised pavement markers	M	-	$245,300	$160,000	$540,000	$0	$5,400,000	$6,100,000
CS 40.4	L10	Franconia Wash WB Bridge #377	13	13	A	Rehabilitate bridge	P	7314	$140	$30,000	$100,000	$0	$1,000,000	$1,130,000
					B	Replace bridge	M	7314	$280	$60,000	$200,000	$0	$2,000,000	$2,260,000
CS 40.5	L11	Illavar Wash EB Bridge #1310	18	18	A	Rehabilitate bridge	P	3776	$140	$20,000	$50,000	$0	$500,000	$570,000
					B	Replace bridge	M	3776	$280	$30,000	$110,000	$0	$1,100,000	$1,240,000
CS 40.6	L12	Flat Top Wash WB Bridge #1312	21	21	A	Rehabilitate bridge	P	6418	$140	$30,000	$90,000	$0	$900,000	$1,020,000
					B	Replace bridge	M	6418	$280	$50,000	$180,000	$0	$1,800,000	$2,030,000
CS 40.7	L17	Griffith Wash WB Bridge #1658	40	40	A	Rehabilitate bridge	P	6289	$140	$30,000	$90,000	$0	$900,000	$1,020,000
					B	Replace bridge	M	6289	$280	$50,000	$180,000	$0	$1,800,000	$2,030,000
CS 40.8	L18	SR-95 to Kingman Safety Improvements	11	43	-	For both EB and WB directions, rehabilitate shoulder, re-install rumble strips, and install high-visibility delineators and raised pavement markers; Provide driver information (advance notice of Rest Area)	M	-	$245,300	$500,000	$1,600,000	$0	$16,000,000	$18,100,000
CS 40.9	L19/L20	Kingman Area Safety and Mobility Improvements	43	55	-	For both EB and WB directions, rehabilitate shoulder, re-install rumble strips, and install high-visibility delineators and raised pavement markers; Install median cable barrier at MP 47-51; Construct climbing lane EB at MP 47-51; Implement Variable Speed Limits (VSL) at MP 47-53 EB/WB and integrate with existing Dynamic Message Sign (DMS) at MP 45 (EB) and MP 55 (WB) to provide driver information	M	12000	$390	$1,000,000	$3,300,000	$500,000	$33,000,000	$37,800,000
CS40.10	L22	Kingman to US 93 Safety Improvements	55	74	-	Construct climbing lane EB at MP 58-60; Install VSL at MP 58-71 EB/WB and integrate with existing DMS at MP 69 (EB) and with new DMS at MP 55 (EB) and MP 72 (WB) to provide driver information	M	-	-	$500,000	$1,700,000	$300,000	$17,000,000	$19,500,000

CS40.11	L27	Willow Creek Safety Improvements	80	98	-	Construct climbing lane EB at MP 81-83 and MP 93-97; Implement VSL at MP 79-83 EB, MP 88-90 EB, and MP 93-97 EB and integrate with existing Roadside Weather Information System (RWIS) at MP 91 and new DMS at MP 79 (EB) to provide driver information	M	4800	$390	$1,200,000	$3,900,000	$800,000	$39,000,000	$44,900,000
CS40.12	L28	Jolly Road Area Safety Improvements	98	108	-	For both EB and WB directions, rehabilitate shoulder, re-install rumble strips, and install high-visibility delineators and raised pavement markers	M	-	$245,300	$250,000	$840,000	$0	$8,400,000	$9,490,000
CS40.13	L30	Anvil Rock Rd TI UP Bridge #1610	110	110	A	Rehabilitate bridge	P	7064	$140	$30,000	$100,000	$0	$1,000,000	$1,130,000
					B	Replace bridge	M	7064	$280	$60,000	$200,000	$0	$2,000,000	$2,260,000
CS 40.14	L40	Johnson Canyon WB Bridge #441	148	148	A	Rehabilitate bridge	P	2340	$140	$10,000	$30,000	$0	$300,000	$340,000
					B	Replace bridge	M	2340	$280	$20,000	$70,000	$0	$700,000	$790,000
CS 40.15	L41	Ash Fork to Williams Safety Improvements	143	160	-	For both EB and WB directions, rehabilitate shoulder, re-install rumble strips, and install high-visibility delineators and raised pavement markers; Construct climbing lane EB at MP 151-152 and MP 156-159; Implement VSL at MP 151-159 EB/WB and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at MP 144 (EB) and with new DMS at MP 160 (WB)	M	-	$245,300	$1,100,000	$3,500,000	$500,000	$35,000,000	$40,100,000
CS 40.16	L43	Williams Area Safety Improvements	160	168	-	For both EB and WB directions, rehabilitate shoulder, re-install rumble strips, and install high-visibility delineators and raised pavement markers; Construct climbing lane WB at MP 162-163; Implement VSL at MP 161-163 EB/WB and integrate with existing RWIS at MP 159 and existing DMS at MP 168 (WB) and with new DMS at MP 160 (EB)	M	-	$245,300	$400,000	$1,200,000	$100,000	$12,000,000	$13,700,000
CS 40.17	L49	West Flagstaff Pavement Improvements	191	196	A	Rehabilitate pavement	P	-	$590,000	$180,000	$590,000	$0	$5,900,000	$6,670,000
					B	Replace pavement and subgrade	M	-	$3,810,000	$1,100,000	$3,800,000	$0	$38,000,000	$42,900,000
CS 40.18	L53	W Flagstaff TI EB #1128	192	192	A	Rehabilitate bridge - re-evaluate FY2019 deck rehab project	P	5313	$140	$20,000	$70,000	$0	$700,000	$790,000
					B	Replace bridge - re-evaluate FY2019 deck rehab project	M	5313	$280	$50,000	$150,000	$0	$1,500,000	$1,700,000
CS 40.19	L54	Flag Ranch TI EB Bridge #2027	193	193	A	Rehabilitate bridge	P	7248	$140	$30,000	$100,000	$0	$1,000,000	$1,130,000
					B	Replace bridge	M	7248	$280	$60,000	$200,000	$0	$2,000,000	$2,260,000
CS 40.20	L56	Woody Mountain Road TI WB Bridge #1133	194	194	A	Rehabilitate bridge	P	5491	$140	$20,000	$80,000	$0	$800,000	$900,000
					B	Replace bridge	M	5491	$280	$50,000	$150,000	$0	$1,500,000	$1,700,000

Appendix B Life-Cycle Cost Analysis and Benefit-Cost Analysis

BRIDGE LCCA

1.1 Introduction

This section presents the results of a Life Cycle Cost Analysis (LCCA) for selected bridges on I-40. The LCCA is one method used to assess the potential for bridges to advance as strategic projects in the set of corridor recommendations, either on their own as a bridge-only strategic project, or combined with other needs on the roadway associated with the bridge. Full replacement is the main case of interest for a strategic bridge project.

The format of this section is as follows.

- how bridge improvements work now
- what is a life cycle cost analysis and why is it performed
- I-40 bridges identified for LCCA (and why)
- the I-40 corridor bridge profile LCCA model
- results of I-40 LCCA and how used in the CPS
- next steps

1.2 How Bridges Are Cared For Now

ADOT's essential objective is to keep each bridge in working order (rating of 4 or higher) in an economical manner. Key considerations involved in achieving this objective include the traffic volumes and role of the roadway facility for which the bridge is a feature, the rate of deterioration of the bridge and its major components or subsystems, the user impact of restrictions or detours should the bridge not perform adequately, and the total funding available for bridge maintenance, repair, rehabilitation, and replacement over a time period. Bridges have a long design life (typically 75 years) so they are seldom completely replaced unless a larger improvement project on the associated roadway is required to add capacity or make other operational or safety improvements.

In a perfect world with adequate funding, ADOT's bridge managers would apply "optimal" or most cost-effective (i.e. economical) corrective actions to maintain a bridge's condition at 4 or higher out of 9. In the less than perfect real world with funding often in short supply, less expensive but sometimes less economical actions are applied to keep the bridges in service due to overall funding limitations. This approach tends to minimize ADOT costs in the short term but can contribute to increased costs in the longer term. If occasional short term funding limitations are followed by adequate funding levels, this adverse consequence can generally be remedied. But if funding limitations become the norm then the avoidable future cost increases can become a serious liability for the agency. The bridge Life Cycle Cost Analysis has been proposed as part of this Corridor Profile Study in order to identify cases where spending more money sooner may provide a more economical strategy over time to keeping a bridge in working order. It also provides an opportunity to consider if other non-bridge needs on the associated roadway may be combined with bridge needs to develop a solution strategy that accomplishes multiple objectives with reduced interruption to the traveling public.

1.3 Life Cycle Cost Analysis – What and Why

Life Cycle Cost Analysis is an economic study that compares the cost stream over time of a set of improvement actions from different alternatives and presents the results in a common measure, the present value of all future costs. The alternatives are focused on achieving the same or very similar objectives from three different strategic approaches. These three strategies are Option 1 Replace immediately, Option 2 Rehabilitate immediately then replacement at 75 years old, and Option 3 Continue ongoing repairs until replacement at 75 years old. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For this bridge life cycle cost analysis the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping a bridge serviceable over a long period of time. LCCA often also includes user costs (i.e. benefits) but those were omitted for this initial analysis except in a qualitative manner. The focus has remained on ADOT agency costs.

The reason for performing life cycle cost analysis is to provide a more complete holistic perspective on asset condition, performance, and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short term costs which often dominate the considerations in transportation investment decision making and programming, especially under severe financial constraints.

In this bridge life cycle cost analysis, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges. These strategies are immediate bridge replacement (large up-front cost but small ongoing costs afterwards), immediate rehabilitation until replacement (moderate up-front costs then small to moderate ongoing costs until replacement), and ongoing repairs until replacement (low up front and ongoing costs until replacement).

1.4 Bridges Selected for I-40 LCCA

Nine bridges were selected for LCCA for I-40. They were selected due to their current ratings and their historical ratings. The bridges selected for LCCA analysis are listed below along with the bridge number and the year ending their typical 75 year life in parentheses.

a. Anvil Rock - #1610 (2047) – carries Anvil Rock Rd over I-40
b. Flag Ranch - #2027 (2041) – carries I-40 EB over Flagstaff Ranch Rd
c. Flat Top Wash - #1312 (2026) – carries I-40 WB over wash
d. Franconia Wash - #377 (2026) – carries I-40 WB over wash
e. Griffith Wash - #369 (2024) – carries I-40 EB over wash
f. Illavar Wash - #1310 (2024) – carries I-40 EB over wash
g. Johnson Canyon - #441 (2030) – carries I-40 WB over canyon
h. West Flagstaff - #1128 (2040) – carries I-40 EB over US 40
i. Woody Mountain - #1133 (2041) – carries Woody Mountain Rd over I-40

Seven of the bridges listed above carry I-40 itself over another road or feature. Two of the bridges carry a roadway overcrossing at a traffic interchange.

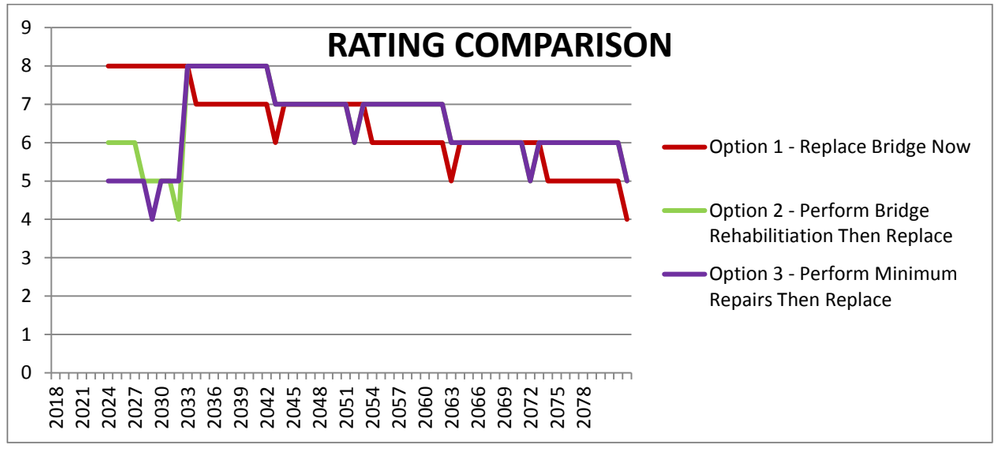
The four bridges “c” through “f” above all have their 75 year end of life occurring before 2030. It was decided after making the LCCA selections that bridges aging out before 2030 need replacement soon enough to be identified for a strategic bridge replacement without further LCCA efforts. They should be checked, however, for possible deck area increases during that replacement to meet current standards and to accommodate any mobility widenings (adding lanes) or lengthenings (widen roadway underneath) that may be driven by other needs on the roadway segment. Thus the other five bridges are the focus of the remaining discussion of LCCA.

1.5 The Corridor Profile Study Bridge LCCA Model Overview

The bridge LCCA model for the Corridor Profile Studies reviews the characteristics of the selected bridges including bridge ratings and deterioration rates to develop three economic improvement strategies as outlined earlier – full replacement, rehabilitation until replacement, and repair until replacement. Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length to span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance.

The effect on the bridge condition over time for each strategy is shown on **Figure 1** for illustration from one of the I-40 bridges, the Johnson Canyon bridge which carries the I-40 mainline over that feature. That chart shows the bridge rating in each year over the analysis period by improvement strategy. Similar charts were generated for the other I-40 LCCA bridges.

Figure 1: Bridge Condition Rating for I-40 Johnson Canyon Bridge by Year by Improvement Strategy



Source: Kimley-Horn 2016

This bridge hits the 75 year replacement limit in 2030. The three strategies have very close <u>average</u> rating over the analysis period – in the range of 6.4 to 6.5 – although they differ year to year.

The costs of the set of improvement actions in each strategy that resulted in the Johnson Canyon bridge ratings chart above is shown in **Table 1**. Agency costs are shown in total $1,000s undiscounted and discounted (present value at 3%) 2015 $ over the 65 year analysis period ending in 2080.

Table 1: Cost of Future Improvement Strategies for Johnson Canyon Bridge

Cost of Strategy: 2021-2080, 2015 $1,000		
OPTION	**Undiscounted**	**PV 3%**
Option 1 (Replace)	$544	$433
Option 2 (Rehab)	$772	$536
Option 3 (Repair)	$563	$359

Source: Kimley-Horn 2016

In this case the Option 1 full replacement immediately is the lowest cost in undiscounted dollars, but the Option 3 repair strategy (followed by replacement when the bridge life hits 75 years) is the lowest cost in discounted dollars, which is a better metric to use. Similar calculations were completed for the other I-40 LCCA bridges. In this case there would not be a strategic bridge project (full replacement) at least from a bridge-only perspective without regard to other needs on the associated roadway.

The next section of this chapter shows how the results are used in identifying candidate strategic bridge projects from the set of bridges selected for LCCA, first looking at the bridges alone, then afterwards looking at the bridges in the context of the other needs on its associated roadway.

1.6 Life Cycle Cost Results

This section reviews the life cycle cost results from several perspectives. These are:

- undiscounted total ADOT costs over the analysis period
- discounted total ADOT costs over the analysis period
- how close the various strategies are
- combining bridge LCCA results with other needs on the connecting roadway

1.6.1 ADOT Future Costs by Bridge Strategy - Undiscounted

Table 2 summarizes the bridge life cycle cost results for the five I-40 bridges selected for this analysis for the three improvement strategies. The results are all in undiscounted 2015 dollars – i.e. no time value of money. The shading colors indicate the rank order of the costs with green as the lowest, yellow as second, and red as highest.

Table 2: Total Costs by Strategy by Bridge - Undiscounted 2015$

I-40 Bridge			ADOT Future Costs: 2021-2080		
			2015 $1,000 Undiscounted		
Item	Name	Number	1-Replace	2-Rehab	3-Repair
1	Anvil Rock	1610	$1,231	$2,094	$1,917
2	Flag Ranch	2027	$1,171	$1,494	$1,331
3	Johnson Canyon	441	$544	$772	$563
4	West Flagstaff	1128	$1,133	$1,419	$1,208
5	Woody Mtn	1133	$1,171	$1,428	$1,221

Source: Kimley-Horn 2016

All three bridges in all improvement strategy cases kept the bridge rating above 4 in an economical manner in all years.

The total cost of mitigation strategies for these five bridges range from a low of $0.5 million to a high of $2.1 million over the analysis period. Full bridge replacement as soon as possible is the lowest cost strategy to keep all five bridges at rating of 4 or higher over the analysis period in an economical manner. Full replacement immediately introduces a major corrective action up front followed by minimal minor repair actions over the remaining years of the analysis period. The Option 3 minimum repair strategy (until required end of life replacement) is second lowest for all five bridges. Rehabilitation followed by replacement is the highest cost strategy.

1.6.2 ADOT Future Costs by Bridge Strategy – Present Value Costs (at 3% discount rate)

The time value of money was not considered in the previous section but is actually a very important consideration. This section describes how discounting future investments affects the comparative results of the different bridge improvement strategies.

Table 3 shows the total cost for the same corrective actions as in Table 2 except that the future expenditures are discounted to present value costs at a 3% annual rate. As with Table 2 the color shading indicates the rank order of the strategies. The order for discounted results is different than for the undiscounted values.

Table 3: Total Costs by Strategy by Bridge - Discounted 2015$

I-40 Bridge			ADOT Future Costs: 2021-2080		
			2015 $1,000 PV 3%		
Item	Name	Number	1-Replace	2-Rehab	3-Repair
1	Anvil Rock	1610	$970	$1,187	$1,029
2	Flag Ranch	2027	$934	$808	$642
3	Johnson Canyon	441	$433	$536	$359
4	West Flagstaff	1128	$903	$771	$591
5	Woody Mtn	1133	$934	$786	$581

Source: Kimley-Horn 2016

In this discounted perspective the Option 1 full replacement is the lowest cost strategy for one bridge - Anvil Rock. Option 1 as lowest cost is very rare as discussed earlier. The factors contributing to this outcome appear to be the bridge's relatively young life combined with a steep deterioration rate which makes replacement immediately somewhat more attractive than band aids actions until it hits its 75 year end of life. Option 3 repair strategy is the lowest cost for the other four bridges. Option 2 Rehabilitation is never the lowest cost strategy although it varies between second and highest cost. Again the average bridge condition rating over the analysis period is similar in all three cases. These results reinforce the experience of ADOT Bridge Group staff that replacing a bridge is a very rare event unless a related mobility or other need creates a larger project within which a full bridge replacement is called for, something that will be examined later in this chapter.

1.6.3 Future Costs Present Value – Tolerance Band Around Lowest Cost Strategy

While the previous section looked at the LCCA present value results in pure rank order, this section examines "how close" the results and rankings are to see if there are differences among strategies that are small enough to be assumed a tie and thus possibly modify the interpretation of results. This test acknowledges the high degree of uncertainty in the life cycle cost analysis at the level of the corridor profile study.

A "tolerance" of 15% of the difference between strategies was established as a tie. This tolerance suggests that if the second lowest cost strategy is within 15% of the lowest cost and the second lowest cost is a more aggressive strategy than the lowest cost strategy, then the two strategies are essentially tied, and the designation for lowest cost goes to the more aggressive strategy.

Table 4 shows the same color ranking as the previous table for discounted total costs. For the second highest cost (yellow shading) and highest cost strategy (red shading), the percentage value shown is the percent that that strategy is above the next lower strategy (yellow to green, and red to yellow). If the yellow is 15% or less then it is tied with the green and the more aggressive strategy of the two is considered lowest cost. If the red value is 15% or less then the red strategy is considered a tie with the yellow strategy which may come into play in the "other needs" consideration presented later in this section. Finally the fourth percentage column on the right is the percent that the highest cost strategy (red shading) is above the lowest cost strategy (green shading). If this percentage is less than or equal to 15% and the highest cost strategy is more aggressive than both the lowest or second cost strategy (i.e. full replacement), then the revised designation of lowest cost strategy goes to the most aggressive strategy – full replacement.

Table 4: Percent Cost Above Next Lower Cost Strategy

I-40 Bridge			% Above Next Lower Value			% High
			Present Value 3%			to Low
Item	Name	Number	1-Replace	2-Rehab	3-Repair	Red/Grn
1	Anvil Rock	1610	0.0%	15.3%	6.1%	22.3%
2	Flag Ranch	2027	15.6%	25.9%	0.0%	45.5%
3	Johnson Canyon	441	20.7%	23.8%	0.0%	49.4%
4	West Flagstaff	1128	17.2%	30.5%	0.0%	53.0%
5	Woody Mtn	1133	18.8%	35.3%	0.0%	60.7%

Source: Kimley-Horn 2016

For I-40 the outright lowest discounted cost strategy was Option 1 replacement for one bridge - Anvil Rock, so the tolerance band is not applicable as replacement is already the most aggressive strategy. For the other four bridges the lowest cost (green) was always Option 3 Repair. The second lowest cost strategy (yellow shading) was never within 15% of the lowest cost or green

strategy. So the tolerance test does not affect the outcomes in this set of bridges. Anvil Rock remains the only strategic bridge replacement from a pure LCCA perspective.

1.6.4 Other Considerations Combined with Life Cycle Cost Analysis

Other considerations in the reassessment of the LCCA results are focused on non-LCCA results that may still identify a bridge for replacement due to a mobility need for widening (or lengthening over another roadway being widened) to add a travel lane to increase roadway capacity. Other non-mobility needs that do not directly affect widening or lengthening may be considered as well. These include pavement, safety, and freight.

The Anvil Rock bridge has already been nominated for a strategic bridge replacement due to Option 1 Replacement having the lowest present value cost. The "Other Needs" test first checks if its deck area should be further modified due to a need for widening for mobility (capacity) reasons, or should be lengthened due to a widening of I-40 underneath it. Neither of these mobility needs have been identified. Furthermore there are no other non-bridge needs from the pavement, safety, or freight categories to be considered. Thus this bridge will advance as a full replacement with its existing capacity and length.

The Flag Ranch bridge had Option 3 Repair as the lowest cost (present value) strategy. There is no mobility need to widen this bridge to add capacity to I-40, nor does it need lengthened due to needs associated with Flagstaff Ranch Road underneath it. There is a pavement need associated with this segment of I-40 but no other needs from safety or freight. Thus there is still no strategic bridge replacement recommendation for this bridge and it defaults to the non-strategic repair until replacement.

The Johnson Canyon bridge had Option 3 Repair as its lowest present value cost strategy. There no mobility need that would widen this bridge to add capacity to I-40. There is a safety need on I-40 in this segment but no pavement or freight needs. Thus there is still no strategic bridge replacement recommendation for this bridge and it defaults to the non-strategic repair until replacement.

The West Flagstaff bridge had Option 3 Repair as its lowest present value cost strategy. There is no mobility need associated with this bridge that would widen it to add capacity to I-40 or lengthen due to changes on US 40 underneath it. There are pavement needs associated with this segment of I-40 but no other needs from safety or freight. Thus there is still no strategic bridge replacement recommendation for this bridge and it defaults to the non-strategic repair until replacement.

Woody Mountain had Option 3 Repair as its lowest present value cost strategy. There are no other mobility needs that would widen this bridge carrying Woody Mountain Road over I-40, or a need to lengthen it due to changes on I-40 underneath it. There are pavement needs on I-40 underneath the bridge and no other needs related to safety or freight. Thus there is still no strategic bridge replacement recommendation for this bridge and it defaults to the non-strategic repair until replacement.

Table 5 summarizes the results of nine bridges that entered the LCCA including the four set aside earlier due to hitting their 75 year end of life before 2030. Five bridges are recommended to advance in the evaluation process as strategic bridge replacements – four due to age of structure and the fifth due to LCCA cost results. The other four default to the usual repair until replacement unless a larger project comes along that includes the bridge replacement.

Table 5: Summary of I-40 Bridge LCCA Results

Item	Bridge Name	Bridge #	75th Year	Carries	Over	LCCA Results	Reason for Replacement
1	Anvil Rock	1610	2047	Anvil Rock Rd	I-40	Replace	LCCA $
2	Flag Ranch	2027	2041	I-40 EB	Road	Repair	N/A
3	Flat Top Wash	1312	2026	I-40 WB	wash	Replace	Age
4	Franconia Wash	377	2026	I-140 WB	wash	Replace	Age
5	Griffith Wash	369	2024	I-40 EB	wash	Replace	Age
6	Illavar Wash	1310	2024	I-40 EB	wash	Replace	Age
7	Johnson Canyon	441	2030	I-40 WB	canyon	Repair	N/A
8	West Flagstaff	1128	2040	I-40 EB	US 40	Repair	N/A
9	Woody Mountain	1133	2041	Woody Mtn Rd	I-40	Repair	N/A

Source: Kimley-Horn 2016

Bridge LCCA

Anvil Rock UP 1610

Bridge Information	
Bridge Deck Area (A225)	7064 SF
Year Built (N27)	1972
Exp Service Life	75 YR
Total Bridge Length (N49)	247 LF
Number of Spans (N45+N46)	2
Skew Angle (N34)	0 DEG
Average Elevation	5709 FT
Max Pier Height	17 FT
* Amount of Widening for Bridge	0 FT
Revised Deck Area (Bridge Replace)	7064 FT
**Scour Critical Rating (N113)	N

Width: 26'

No Scour Rating (UP)

Deterioration Slope				
Item	Deterioration Line Equation			Year
	Slope =	Days	Years	Drop
Substr	y =	-1.000000x	-365.000x	20.00
Superstr	y =	-0.000800x	-0.292x	3.42
Deck	y =	-0.000800x	-0.292x	3.42

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	5709	1.25
Pier Height > 30ft	17	1.00
Length to # span ratio	123.50	1
Skew > 30degrees	0.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$343.75

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$171.88	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$85.94	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$85.94	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$171.88	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$85.94	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$85.94	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

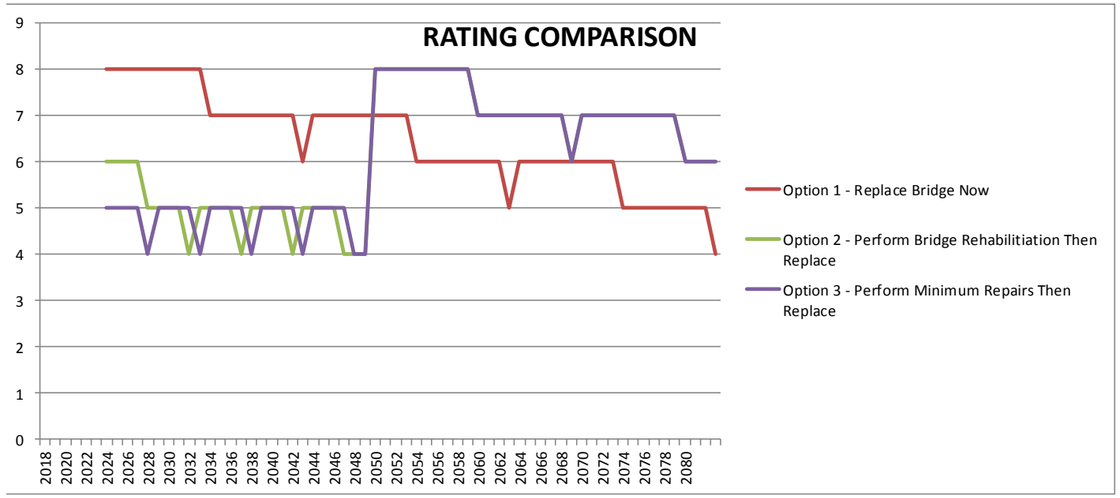
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

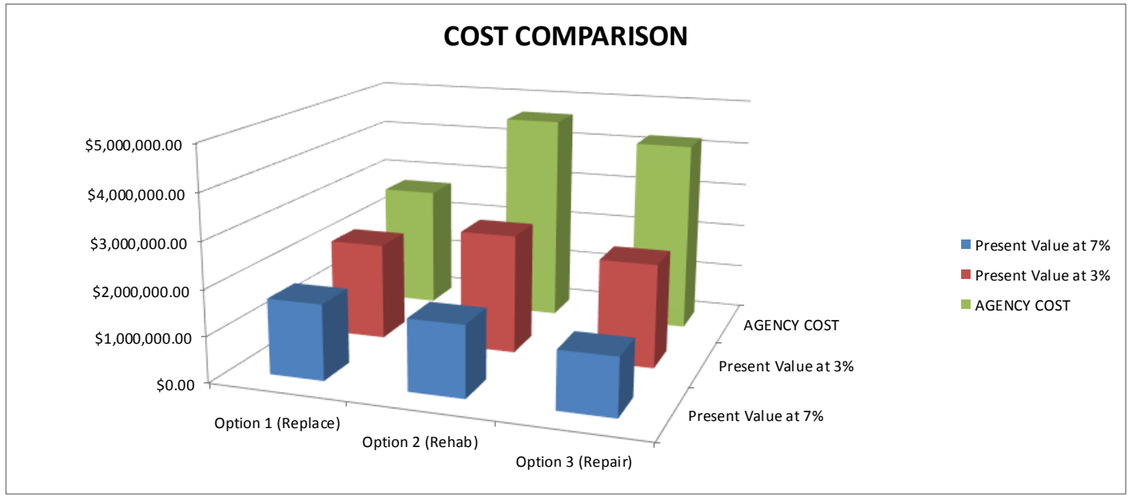
Anvil Rock UP 1610

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 2,707,984.40	$2,134,385.85	$1,648,353.90
Option 2 (Rehab)	$ 4,606,875.90	$2,611,217.67	$1,549,677.20
Option 3 (Repair)	$ 4,217,384.60	$2,264,683.09	$1,252,745.94

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	58.78%	81.74%	106.37%
3 (Repair)	64.21%	94.25%	131.58%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.18	6
Option 3 (Repair)	8.00	6





Flag Ranch EB 2027

Bridge Information	
Bridge Deck Area (A225)	5491 SF
Year Built (N27)	1966
Exp Service Life	75 YR
Total Bridge Length (N49)	176 LF
Number of Spans (N45+N46)	3
Skew Angle (N34)	30 DEG
Average Elevation	7444 FT
Max Pier Height	16 FT
* Amount of Widening for Bridge	0 FT
Revised Deck Area (Bridge Replace)	5491 FT
**Scour Critical Rating (N113)	N

Width: 26'

No Scour Rating (UP)

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000200x	-0.073x	13.70
Superstr	y =	-0.000600x	-0.219x	4.57
Deck	y =	-0.000300x	-0.110x	9.13

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	7444	1.25
Pier Height > 30ft	16	1.00
Length to # span ratio	58.67	1.25
Skew > 30degrees	30.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$429.69

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$214.85	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$107.42	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$107.42	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$214.85	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$107.42	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$107.42	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

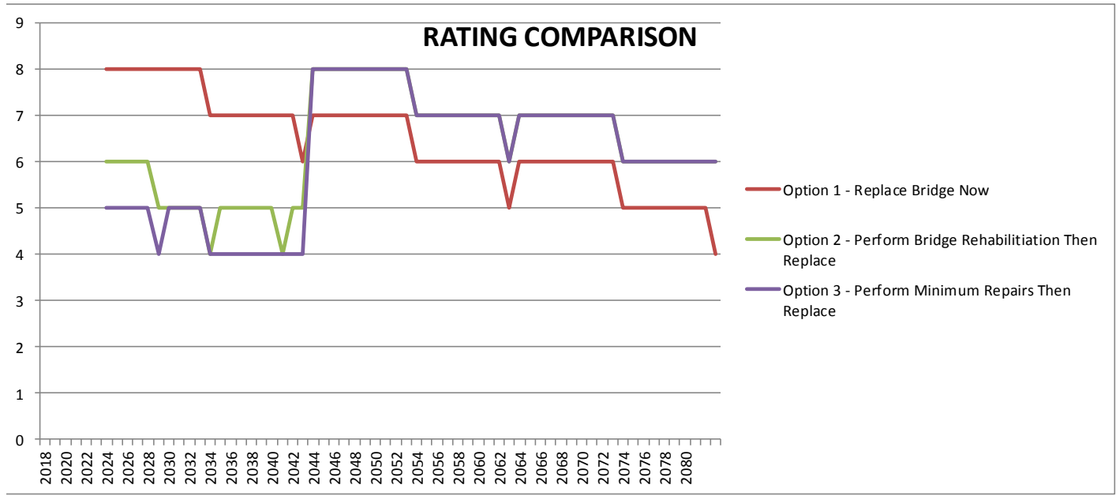
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

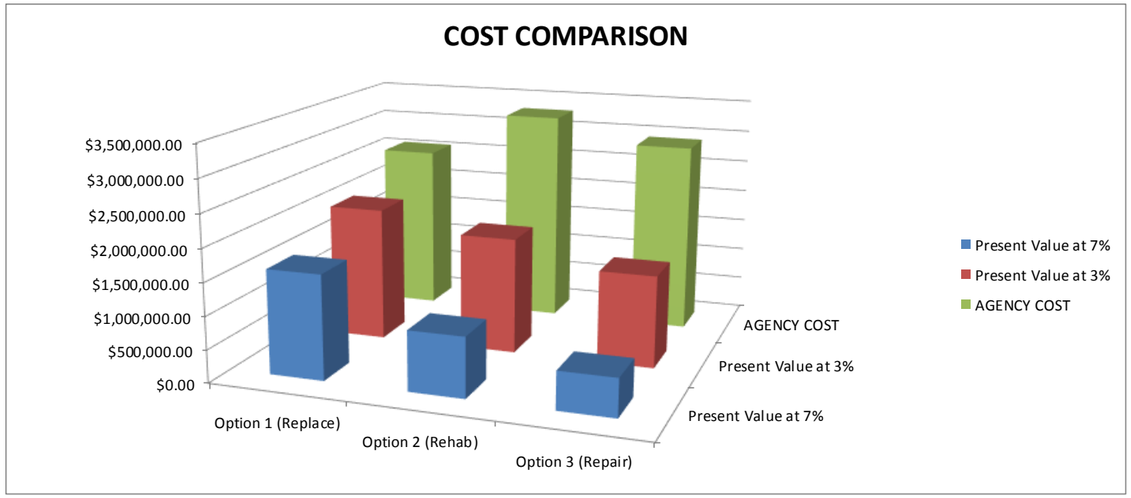
Flag Ranch EB 2027

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 2,576,871.39	$2,054,310.21	$1,595,745.73
Option 2 (Rehab)	$ 3,287,530.34	$1,776,952.44	$912,645.68
Option 3 (Repair)	$ 2,927,197.19	$1,411,826.53	$578,261.39

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	78.38%	115.61%	174.85%
3 (Repair)	88.03%	145.51%	275.96%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.37	6
Option 3 (Repair)	8.00	6





Flat Top Wash (1312)

Bridge Information	
Bridge Deck Area (A225)	6418 SF
Year Built (N27)	1951
Exp Service Life	75 YR
Total Bridge Length (N49)	142 LF
Number of Spans (N45+N46)	5
Skew Angle (N34)	42 DEG
Average Elevation	1646 FT
Max Pier Height	31 FT
* Amount of Widening for Bridge	6 FT
Revised Deck Area (Bridge Replace)	7270 FT
**Scour Critical Rating (N113)	7

Width: 38

Widen to 44'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-1.000000x	-365.000x	0.00
Superstr	y =	-0.000500x	-0.183x	5.48
Deck	y =	-0.000500x	-0.183x	5.48

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	1646	1.00
Pier Height > 30ft	31	1.10
Length to # span ratio	28.40	1.25
Skew > 30degrees	42.00	1.10

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$415.94

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$207.97	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$415.94	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$207.97	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$103.99	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$207.97	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$103.99	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$415.94	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$207.97	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$103.99	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$103.99	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$415.94	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

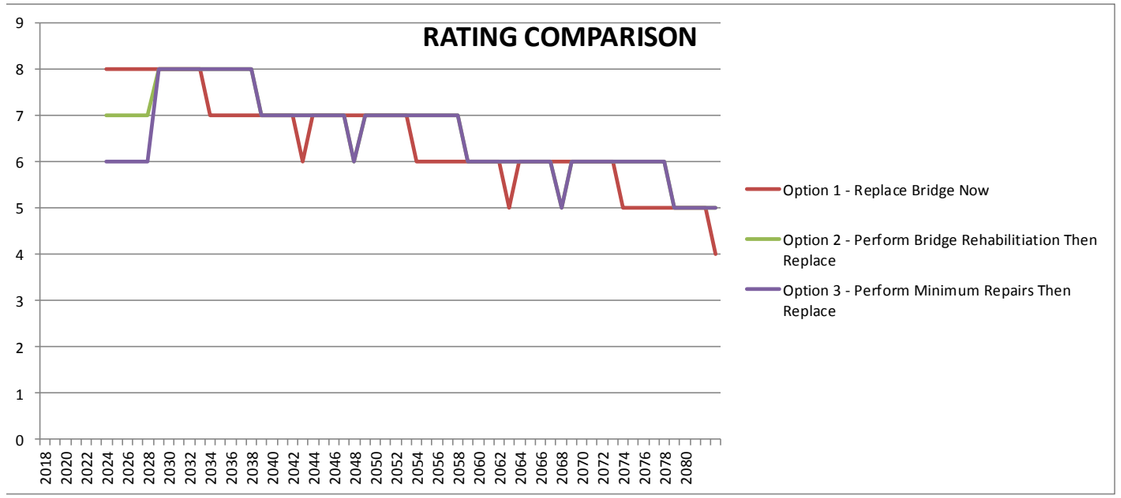
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

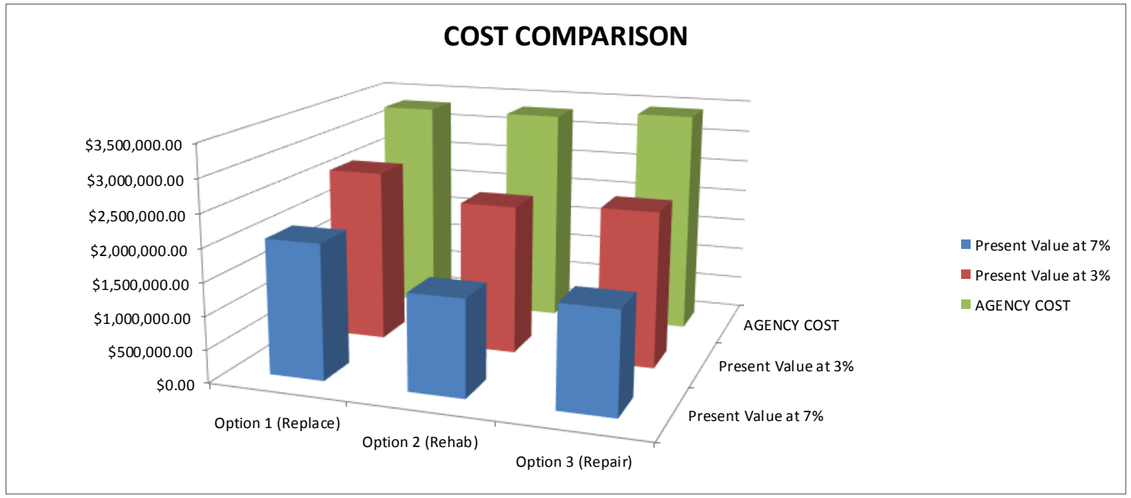
Flat Top Wash (1312)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 3,311,775.80	$2,636,158.27	$2,046,133.70
Option 2 (Rehab)	$ 3,311,775.80	$2,273,973.28	$1,458,865.05
Option 3 (Repair)	$ 3,424,732.60	$2,368,572.83	$1,534,132.94

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	100.00%	115.93%	140.26%
3 (Repair)	96.70%	111.30%	133.37%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.63	5
Option 3 (Repair)	8.00	5





Franconia Wash WB (377)

Bridge Information	
Bridge Deck Area (A225)	7314 SF
Year Built (N27)	1951
Exp Service Life	75 YR
Total Bridge Length (N49)	164 LF
Number of Spans (N45+N46)	7
Skew Angle (N34)	0 DEG
Average Elevation	1166 FT
Max Pier Height	29 FT
* Amount of Widening for Bridge	4 FT
Revised Deck Area (Bridge Replace)	7970 FT
**Scour Critical Rating (N113)	7

Assumed to be less than 30'

Width: 40' Widen to 44'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-1.000000x	-365.000x	0.00
Superstr	y =	-0.000500x	-0.183x	5.48
Deck	y =	-0.000600x	-0.219x	4.57

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	1166	1.00
Pier Height > 30ft	29	1.00
Length to # span ratio	23.43	1.25
Skew > 30degrees	0.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$343.75

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$171.88	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$85.94	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$85.94	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$171.88	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$85.94	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$85.94	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

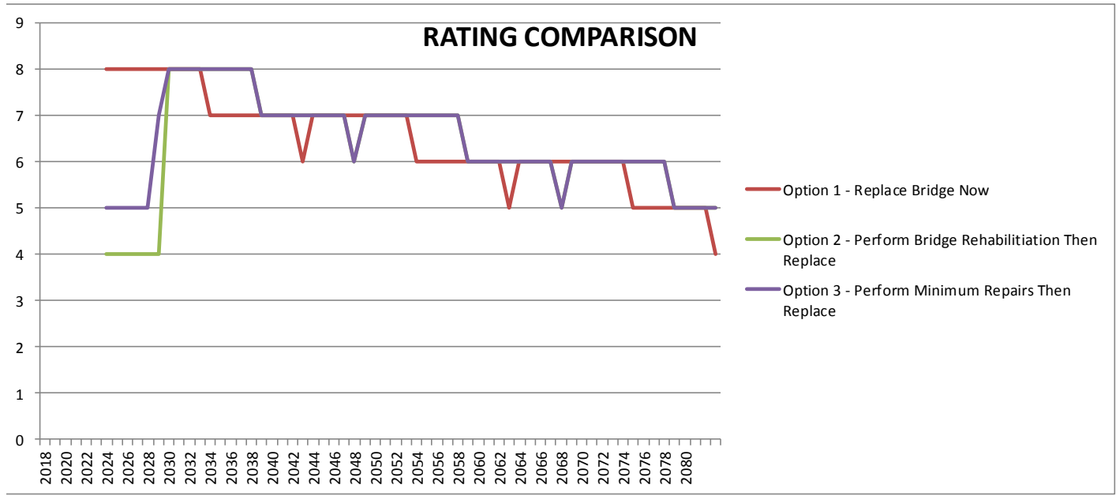
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

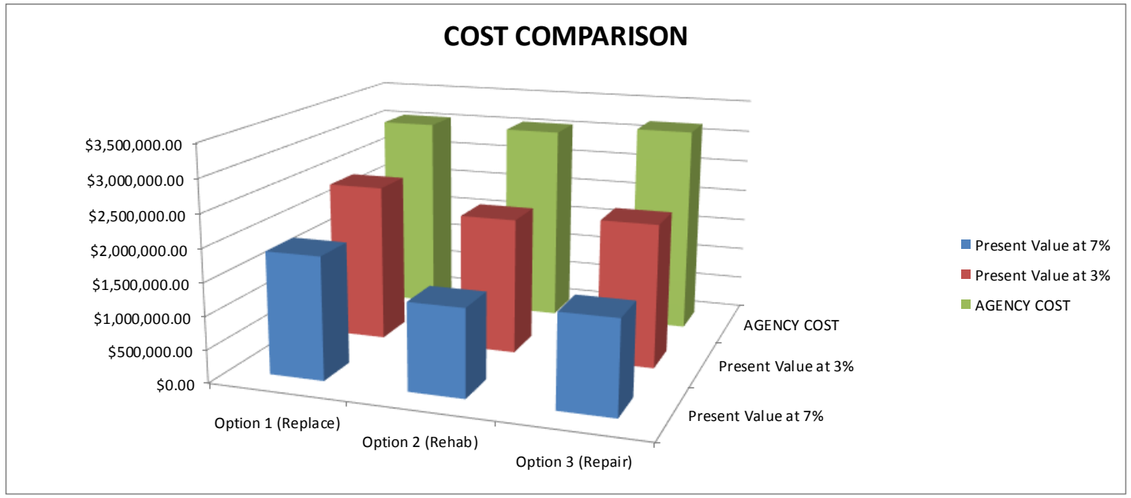
Franconia Wash WB (377)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 3,055,299.50	$2,408,133.52	$1,859,765.09
Option 2 (Rehab)	$ 3,055,299.50	$2,077,277.13	$1,325,986.80
Option 3 (Repair)	$ 3,184,025.90	$2,185,083.47	$1,411,762.64

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	100.00%	115.93%	140.26%
3 (Repair)	95.96%	110.21%	131.73%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.47	4
Option 2 (Rehab)	6.32	5
Option 3 (Repair)	8.00	5





Griffith Wash (369)

Bridge Information	
Bridge Deck Area (A225)	7064 SF
Year Built (N27)	1949
Exp Service Life	75 YR
Total Bridge Length (N49)	140 LF
Number of Spans (N45+N46)	5
Skew Angle (N34)	0 DEG
Average Elevation	2599 FT
Max Pier Height	25 FT
* Amount of Widening for Bridge	2 FT
Revised Deck Area (Bridge Replace)	7344 FT
**Scour Critical Rating (N113)	7

Assumed to be less than 30'

Width: 42 Widen to 44'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-1.000000x	-365.000x	0.00
Superstr	y =	-0.000400x	-0.146x	6.85
Deck	y =	-0.000300x	-0.110x	9.13

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	2599	1.00
Pier Height > 30ft	25	1.00
Length to # span ratio	28.00	1.25
Skew > 30degrees	0.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$343.75

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**T COST WITH CONST. FACTOR (Pe**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$171.88	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**T COST WITH CONST. FACTOR (Pe**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$85.94	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**T COST WITH CONST. FACTOR (Pe**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$85.94	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**T COST WITH CONST. FACTOR (Pe**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$171.88	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$85.94	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**T COST WITH CONST. FACTOR (Pe**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$85.94	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

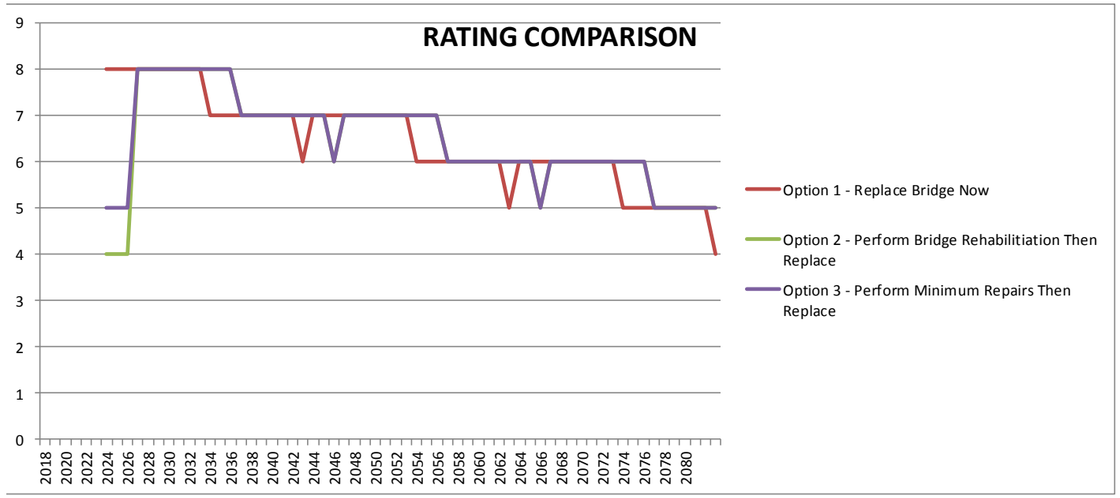
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

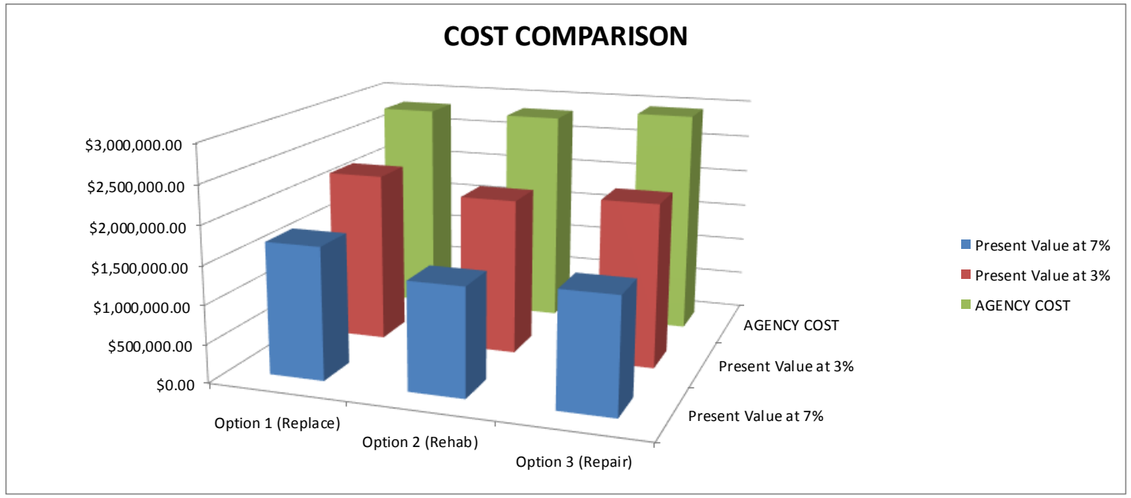
Griffith Wash (369)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 2,815,322.40	$2,218,987.78	$1,713,690.69
Option 2 (Rehab)	$ 2,815,322.40	$2,030,688.16	$1,398,882.07
Option 3 (Repair)	$ 2,939,648.80	$2,134,809.56	$1,481,726.00

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	100.00%	109.27%	122.50%
3 (Repair)	95.77%	103.94%	115.66%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.42	5
Option 3 (Repair)	8.00	5





Illavar Wash EB (1310)

Bridge Information	
Bridge Deck Area (A225)	7064 SF
Year Built (N27)	1949
Exp Service Life	75 YR
Total Bridge Length (N49)	140 LF
Number of Spans (N45+N46)	5
Skew Angle (N34)	0 DEG
Average Elevation	2599 FT
Max Pier Height	25 FT
* Amount of Widening for Bridge	6 FT
Revised Deck Area (Bridge Replace)	7904 FT
**Scour Critical Rating (N113)	7

Assumed to be less than 30'

Width: 38'

Widen to 44'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-1.000000x	-365.000x	0.00
Superstr	y =	-0.000600x	-0.219x	4.57
Deck	y =	-0.000600x	-0.219x	4.57

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	2599	1.00
Pier Height > 30ft	25	1.00
Length to # span ratio	28.00	1.25
Skew > 30degrees	0.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$343.75

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$171.88	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$85.94	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$171.88	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$85.94	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$171.88	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$85.94	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. FACTOR (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$85.94	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$343.75	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

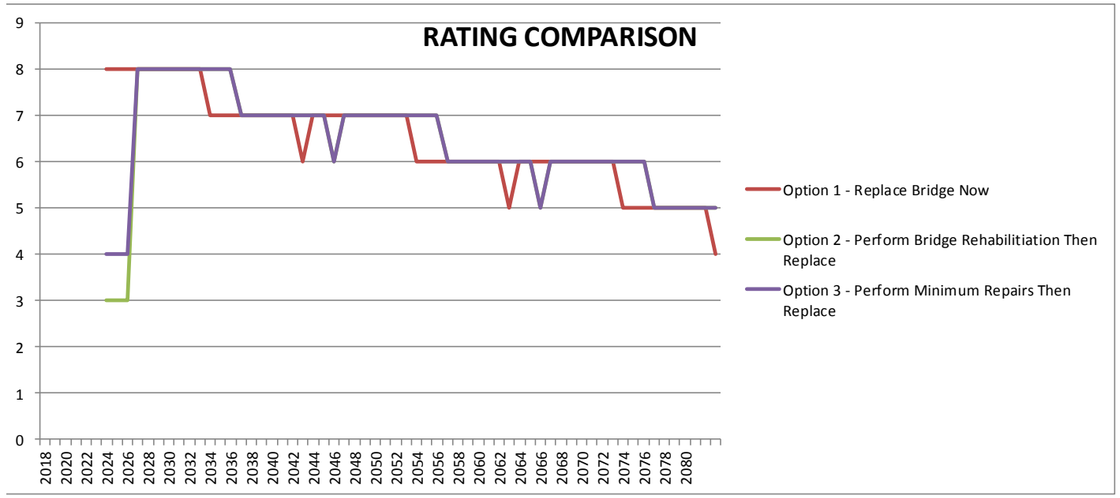
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

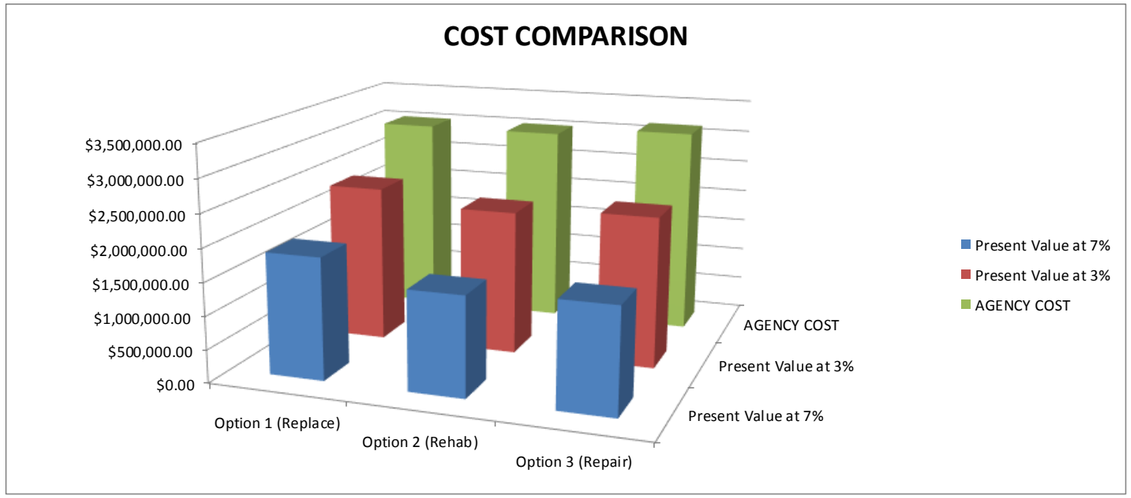
Illavar Wash EB (1310)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 3,029,998.40	$2,388,191.64	$1,844,364.27
Option 2 (Rehab)	$ 3,029,998.40	$2,185,533.66	$1,505,550.64
Option 3 (Repair)	$ 3,154,324.80	$2,289,655.06	$1,588,394.57

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	100.00%	109.27%	122.50%
3 (Repair)	96.06%	104.30%	116.11%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.37	5
Option 3 (Repair)	8.00	5





Johnson Canyon Wash (441)

Bridge Information	
Bridge Deck Area (A225)	2340 SF
Year Built (N27)	1955
Exp Service Life	75 YR
Total Bridge Length (N49)	52 LF
Number of Spans (N45+N46)	2
Skew Angle (N34)	20 DEG
Average Elevation	5309 FT
Max Pier Height	25 FT
* Amount of Widening for Bridge	4 FT
Revised Deck Area (Bridge Replace)	2548 FT
**Scour Critical Rating (N113)	7

Assumed to be less than 30'

Width: 40'

Widen to 44'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000400x	-0.146x	6.85
Superstr	y =	-0.000700x	-0.256x	3.91
Deck	y =	-0.000400x	-0.146x	6.85

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	5309	1.25
Pier Height > 30ft	25	1.00
Length to # span ratio	26.00	1.25
Skew > 30degrees	20.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$429.69

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**IIT COST WITH CONST. COST (Per**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$214.85	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**IIT COST WITH CONST. COST (Per**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$107.42	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**IIT COST WITH CONST. COST (Per**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$107.42	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**IIT COST WITH CONST. COST (Per**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$214.85	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$107.42	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**IIT COST WITH CONST. COST (Per**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$107.42	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

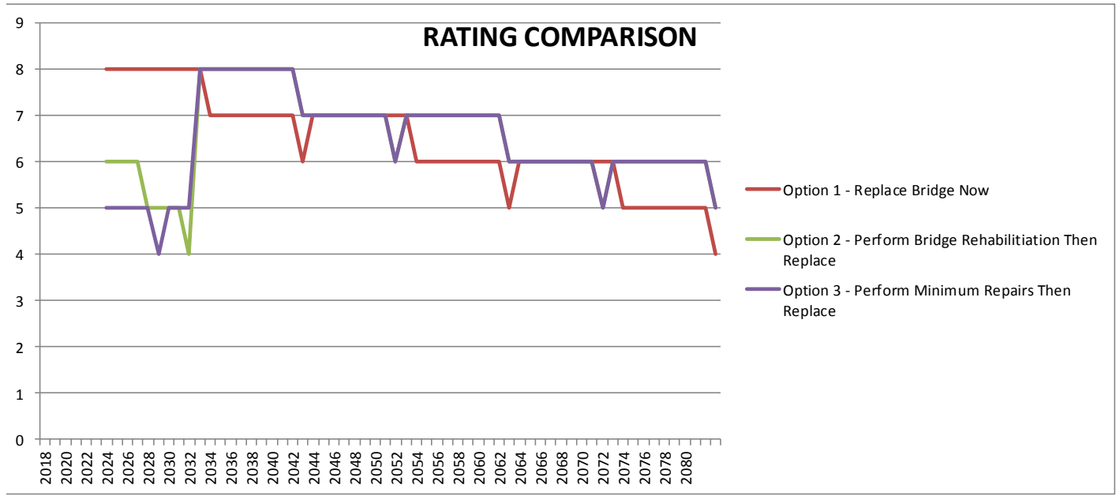
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

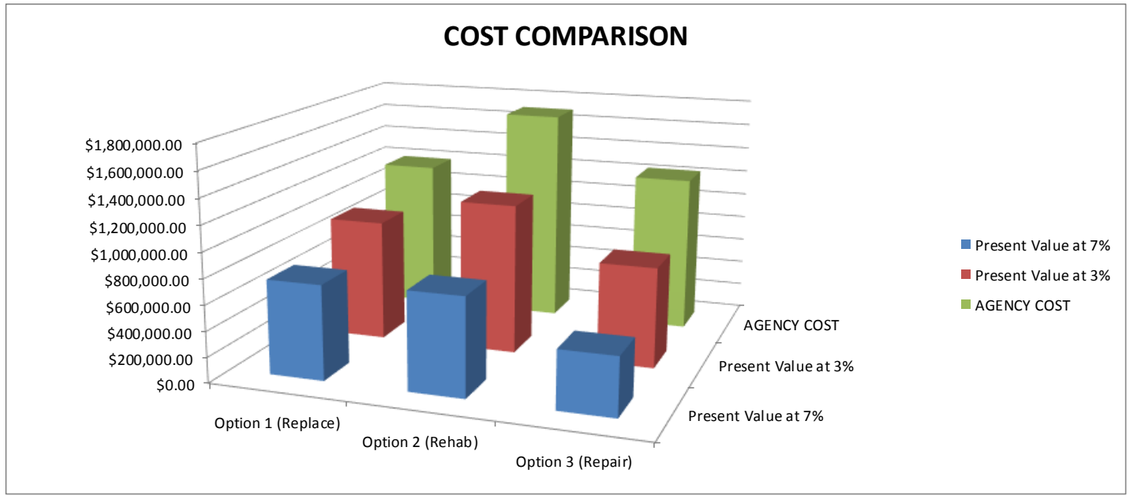
Johnson Canyon Wash (441)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 1,195,750.92	$953,265.78	$740,477.17
Option 2 (Rehab)	$ 1,699,517.82	$1,179,843.35	$768,367.43
Option 3 (Repair)	$ 1,237,964.52	$789,796.41	$455,092.19

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	70.36%	80.80%	96.37%
3 (Repair)	96.59%	120.70%	162.71%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.52	5
Option 3 (Repair)	8.00	5





West Flagstaff EB TI (1128)

Bridge Information	
Bridge Deck Area (A225)	5313 SF
Year Built (N27)	1965
Exp Service Life	75 YR
Total Bridge Length (N49)	123 LF
Number of Spans (N45+N46)	3
Skew Angle (N34)	14 DEG
Average Elevation	7262 FT
Max Pier Height	15 FT
* Amount of Widening for Bridge	0 FT
Revised Deck Area (Bridge Replace)	5313 FT
**Scour Critical Rating (N113)	0

Assumed to be less than 30'

No Scour Rating

Width: 38'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000200x	-0.073x	13.70
Superstr	y =	-0.000600x	-0.219x	4.57
Deck	y =	-0.000300x	-0.110x	9.13

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	7262	1.25
Pier Height > 30ft	15	1.00
Length to # span ratio	41.00	1.25
Skew > 30degrees	14.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$429.69

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$214.85	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$6.60	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$107.42	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$107.42	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$214.85	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$107.42	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$107.42	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

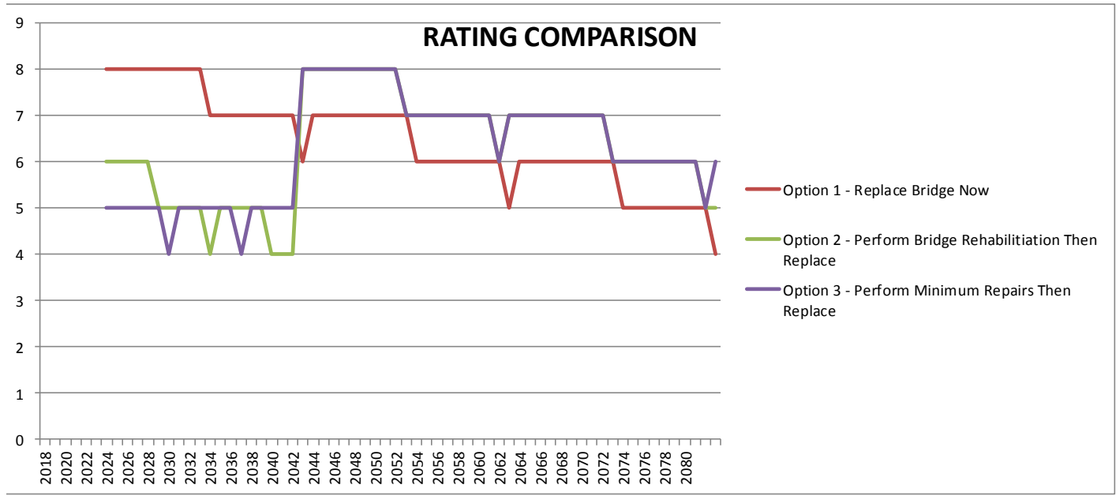
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

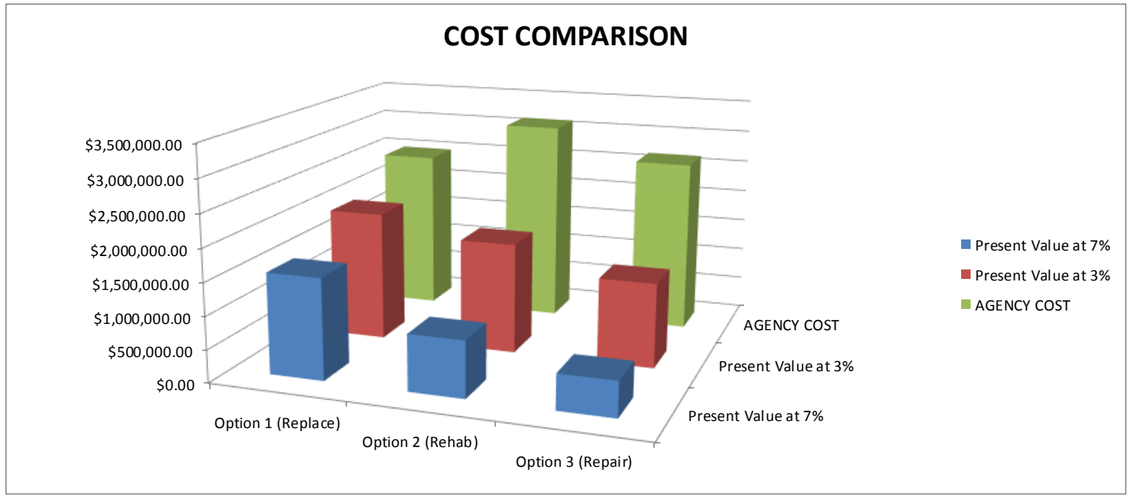
West Flagstaff EB TI (1128)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 2,493,337.77	$1,987,716.29	$1,544,016.95
Option 2 (Rehab)	$ 3,122,516.51	$1,695,824.63	$859,224.01
Option 3 (Repair)	$ 2,656,978.17	$1,299,149.66	$538,390.64

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	79.85%	117.21%	179.70%
3 (Repair)	93.84%	153.00%	286.78%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.32	5
Option 3 (Repair)	8.00	6





Woody Mountain TI WB (1133)

Bridge Information	
Bridge Deck Area (A225)	5491 SF
Year Built (N27)	1966
Exp Service Life	75 YR
Total Bridge Length (N49)	176 LF
Number of Spans (N45+N46)	3
Skew Angle (N34)	30 DEG
Average Elevation	7143 FT
Max Pier Height	16 FT
* Amount of Widening for Bridge	0 FT
Revised Deck Area (Bridge Replace)	5491 FT
**Scour Critical Rating (N113)	0

Assumed to be less than 30'

No Scour Rating

Width: 26'

Deterioration Slope				
Item	Deterioration Line Equation			Year Drop
	Slope =	Days	Years	
Substr	y =	-0.000200x	-0.073x	13.70
Superstr	y =	-0.000600x	-0.219x	4.57
Deck	y =	-0.000200x	-0.073x	13.70

Assume 20 years per point drop

***Input 0 if no widening. Input should include widening on both sides of bridge if applicable.**

****If scour critical rating is 3 or lower, Option 2 should consider the implementation of scour countermeasures.**

Notes:

1. Widening is intended only to correct lane and/or shoulder width deficiencies. It is not intended for adding traffic capacity (i.e. adding general purpose lanes).

Cost Multipliers		
Elevation > 4000ft	7143	1.25
Pier Height > 30ft	16	1.00
Length to # span ratio	58.67	1.25
Skew > 30degrees	30.00	1.00

L to # Span Multiplier	
L/ # Span Ratio	Multiplier
=>100	1.00
=>60	1.10
<60	1.25

Skew Multiplier	
Skew	Multiplier
<30	1.00
=>30	1.10

Adjusted Bridge Replace Cost	
Base Bridge Replacement Cost (Per SF)	$275.00
Bridge Replacement Cost w/ Multipliers (Per SF)	$429.69

Elevation Multiplier	
Elev	Multiplier
<4000	1.00
=>4000	1.25

Pier H Multiplier	
Pier H	Multiplier
<30	1.00
=>30	1.10

Replace / Rehab / Repair Information

BRIDGE DECK				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Deck)	Full Deck Replacement	$214.85	25	Rating = 8
Rehab (Deck Concrete Overlay)	Overlay (Concrete)	$22.00	15	+ 2
Rehab (Deck Epoxy Overlay)	Overlay (Epoxy)	$11.00	10	+ 1
Repair (Deck)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 0
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 0
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 0

SUPERSTRUCTURE - STEEL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Stl)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Stl)	Weld New Structural Components	$107.42	15	+ 2
Repair (Supr - Stl)	Weld Repair / Crack Relief	$11.00	See Deterioration Slope	+ 1

SUPERSTRUCTURE - CONCRETE				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Supr - Conc)	Full SuperStr Replacement	$214.85	50	Rating = 8
Rehab (Supr - Conc)	Replace Structural Component	$107.42	15	+ 2
Repair (Supr - Conc)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

SUBSTRUCTURE - STRUCTURAL				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Replace (Substr)	Full SubStr Replacement	$214.85	75	Rating = 8
Rehab (Substr)	Replace Structural Component	$107.42	50	+ 2
Repair (Substr)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1

SUBSTRUCTURE - SCOUR				
ITEM	**DESCRIPTION**	**UNIT COST WITH CONST. COST (Per SF)**	**LIFE (YRS)**	**RATING BENEFIT**
Rehab (Substr - Scour)	Add scour protection slabs	$107.42	50	+ 2
Repair (Substr - Scour)	Patch Spalls / Seal Cracks	$11.00	See Deterioration Slope	+ 1
Replace (Bridge)	Full Bridge Replacement	$429.69	75	Rating = 8
Repair (After Bridge Replace)	Patch Spalls / Seal Cracks	$6.60	20	+ 1
Repair (After Rehab)	Patch Spalls / Seal Cracks	$6.60	10	+ 1

Notes:

1. Individual replacements assume 50% of total bridge replacement costs

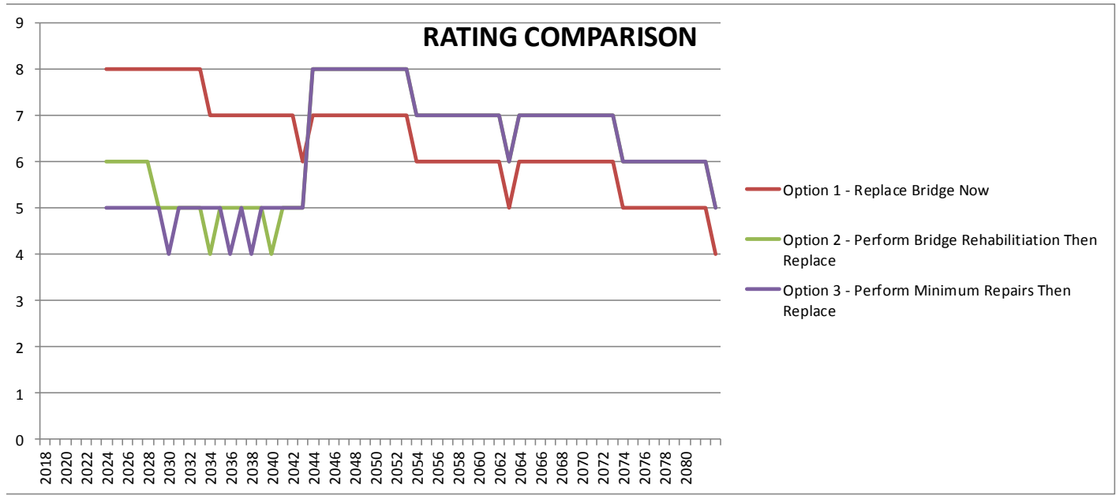
2. Individual rehabs (in cells that are not highlighted) assume 25% of total bridge replacement costs

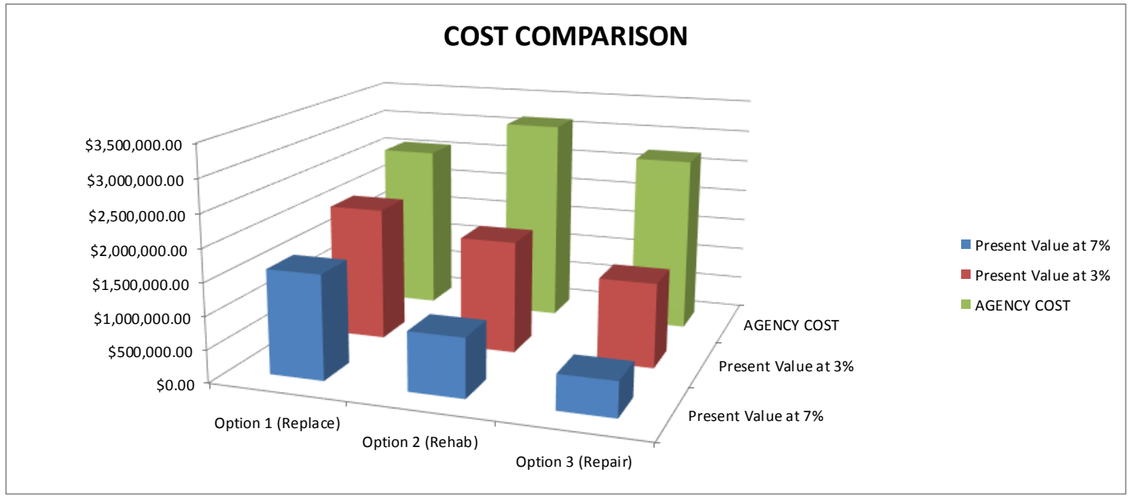
Woody Mountain TI WB (1133)

COST COMPARISON Present Value Dollars			
OPTION	AGENCY COST	3%	7%
Option 1 (Replace)	$ 2,576,871.39	$2,054,310.21	$1,595,745.73
Option 2 (Rehab)	$ 3,142,567.94	$1,729,508.88	$898,942.58
Option 3 (Repair)	$ 2,709,753.59	$1,298,712.84	$533,381.92

Comparison to Replacement			
Option	Agency Cost	3%	7%
2 (Rehab)	82.00%	118.78%	177.51%
3 (Repair)	95.10%	158.18%	299.18%

Bridge Ratings Per Option		
OPTION	AVG RATING	END RATING
Option 1 (Replace)	6.45	4
Option 2 (Rehab)	6.35	5
Option 3 (Repair)	8.00	5





Pavement LCCA

Project Details	
Project Description	Life-Cycle Cost Analysis for I-40 Corridor Profile Study: MP 3-8
Location #	I-40
Milepost Begin	3
Milepost End	8

Roadway Characteristics			
Functional Classification	=	Interstate	
Surface Type	=	Asphalt	‹‹Select from List
Traffic Directions	=	2	‹‹one-way or two-way traffic?
Number of Lanes [each direction]	=	2	
Width of Lanes (ft)	=	12	
Left shoulder width (ft)	=	4	
Right shoulder width (ft)	=	10	
Total Roadway Length (centerline miles)	=	5	
Current PSR Score	=		
Current Year	=	2015	
Roadway Width (ft) [each direction lanes & shoulders]	=	38	
Total Lane-Miles [Total traffic direction lanes & shoulders]	=	31.7	
Total Square Feet [Total traffic direction lanes & shoulders]	=	2,006,400	
Total Square Yards [Total traffic direction lanes & shoulders]	=	222,933	

LCCA Parameters		
Analysis Period (Years)	=	40
Year of Net Present Value	=	2016
First Year of Improvements	=	2020
Discount Rate (%) - Low	=	3%
Discount Rate (%) - High	=	7%
Number of Design Alternatives	=	6
Trigger Level for Rehabilitation (PSR)	=	3.4

Design Alternatives (DA)

Pavement Material Cost ($)

Treatment Type	Pavement Thickness	Typical Service Life	Lane-miles	Square Feet	Square Yards
Concrete Reconstruction	8"-12"	15-25	$350,000	$5.5	$50
Asphalt Reconstruction	8"-12"	10-20	$280,000	$4.4	$40
Concrete Medium Rehab	1"-3"	11-15	$75,000	$1.2	$11
Concrete Light Rehab	<1"	6-10	$50,000	$0.8	$7
Asphalt Medium Rehab	3"-8"	8-12	$105,000	$1.7	$15
Asphalt Light Rehab	<3"	3-7	$70,000	$1.1	$10

Reconstruction: Other Materials Cost Factor

1.60

Rehab: Other Materials Cost Factor

1.20

Total Cost Factor (e.g., includes design, mobilization, traffic control, contingency, etc.)

2.44

Total Unit Cost ($) [includes material costs and indirect costs] **Total Bi-Directional Cost ($)**

Treatment Type	Pavement Thickness	Typical Service Life	Lane-miles	Square Feet	Square Yards	Total Cost
Concrete Reconstruction	8"-12"	15-25	$1,366,400	$21.6	$194	$43,269,333
Asphalt Reconstruction	8"-12"	10-20	$1,093,120	$17.3	$155	$34,615,467
Concrete Medium Rehab	1"-3"	11-15	$219,600	$3.5	$31	$6,954,000
Concrete Light Rehab	<1"	6-10	$146,400	$2.3	$21	$4,636,000
Asphalt Medium Rehab	3"-8"	8-12	$307,440	$4.9	$44	$9,735,600
Asphalt Light Rehab	<3"	3-7	$204,960	$3.2	$29	$6,490,400

		Concrete Reconstruction	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Concrete Reconstruction	$43,269,333	$38,444,242	$33,009,967
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	None	$0	$0	$0
14	2029	None	$0	$0	$0
15	2030	None	$0	$0	$0
16	2031	Concrete Light Rehab	$4,636,000	$2,975,672	$1,680,300
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	Concrete Medium Rehab	$6,954,000	$3,629,240	$1,569,609
24	2039	None	$0	$0	$0
25	2040	None	$0	$0	$0
26	2041	None	$0	$0	$0
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	None	$0	$0	$0
31	2046	None	$0	$0	$0
32	2047	Concrete Light Rehab	$4,636,000	$1,854,340	$569,176
33	2048	None	$0	$0	$0
34	2049	None	$0	$0	$0
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	Concrete Reconstruction	$43,269,333	$14,072,319	$3,308,237
40	2055	None	$0	$0	$0
41	2056	None	$0	$0	$0
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	None	$0	$0	$0
Pick Last Improvement to calculate Remaining Service Life ››		Concrete Reconstruction	$27,997,804	$7,625,812	$1,426,388
Enter Year of Last Improvement ››		2054	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$53,350,002	$38,710,901
AGENCY COST	$74,766,863	

		Asphalt Reconstruction	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Reconstruction	$34,615,467	$30,755,394	$26,407,974
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	None	$0	$0	$0
14	2029	Asphalt Light Rehab	$6,490,400	$4,419,647	$2,693,285
15	2030	None	$0	$0	$0
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	Asphalt Medium Rehab	$9,735,600	$5,718,639	$2,880,413
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	None	$0	$0	$0
24	2039	None	$0	$0	$0
25	2040	None	$0	$0	$0
26	2041	Asphalt Light Rehab	$6,490,400	$3,099,851	$1,195,851
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	None	$0	$0	$0
31	2046	Asphalt Reconstruction	$34,615,467	$14,261,114	$4,547,334
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	None	$0	$0	$0
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	Asphalt Light Rehab	$6,490,400	$2,049,367	$463,772
41	2056	None	$0	$0	$0
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Enter Year of Last Improvement ››		2060	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$60,304,011	$38,188,628
AGENCY COST	$98,437,733	

		Asphalt Medium Rehab Focus	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Medium Rehab	$9,735,600	$8,649,955	$7,427,243
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	Asphalt Light Rehab	$6,490,400	$4,829,467	$3,299,390
12	2027	None	$0	$0	$0
13	2028	None	$0	$0	$0
14	2029	None	$0	$0	$0
15	2030	Asphalt Reconstruction	$34,615,467	$22,884,901	$13,424,475
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	None	$0	$0	$0
24	2039	Asphalt Light Rehab	$6,490,400	$3,288,632	$1,369,130
25	2040	None	$0	$0	$0
26	2041	None	$0	$0	$0
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	Asphalt Medium Rehab	$9,735,600	$4,255,204	$1,464,256
30	2045	None	$0	$0	$0
31	2046	None	$0	$0	$0
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	None	$0	$0	$0
35	2050	None	$0	$0	$0
36	2051	Asphalt Light Rehab	$6,490,400	$2,306,580	$607,910
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	None	$0	$0	$0
41	2056	Asphalt Reconstruction	$34,615,467	$10,611,608	$2,311,634
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	None	$0	$0	$0
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Reconstruction	$23,076,978	$6,285,518	$1,175,690
Enter Year of Last Improvement ››		2056	Remaining Service Life Cost ››		

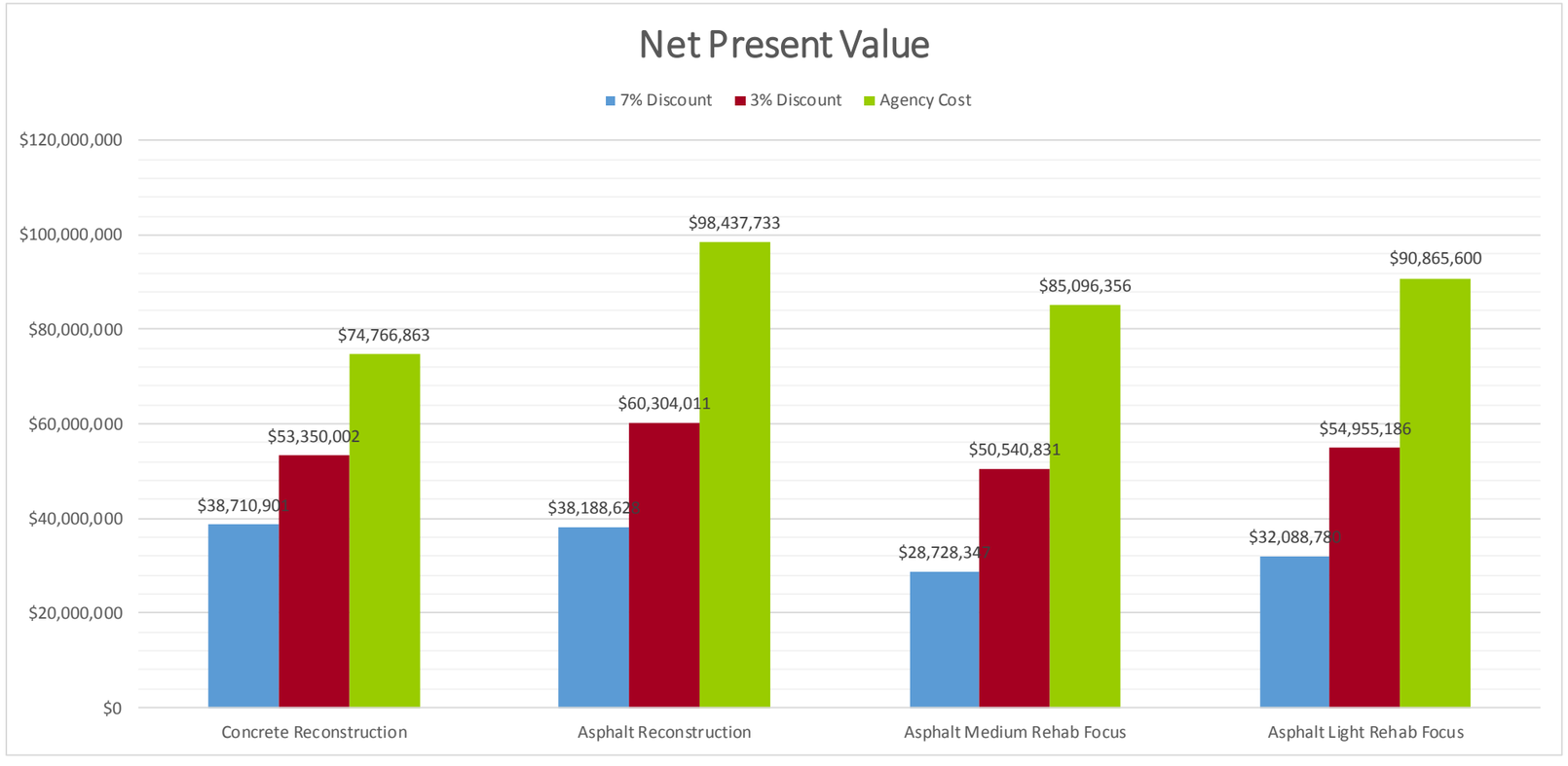
	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$50,540,831	$28,728,347
AGENCY COST	$85,096,356	

		Asphalt Light Rehab Focus	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Light Rehab	$6,490,400	$5,766,636	$4,951,495
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	Asphalt Medium Rehab	$9,735,600	$7,915,934	$6,062,842
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	Asphalt Reconstruction	$34,615,467	$24,278,592	$15,369,681
14	2029	None	$0	$0	$0
15	2030	None	$0	$0	$0
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	Asphalt Light Rehab	$6,490,400	$3,488,910	$1,567,517
23	2038	None	$0	$0	$0
24	2039	None	$0	$0	$0
25	2040	None	$0	$0	$0
26	2041	None	$0	$0	$0
27	2042	Asphalt Medium Rehab	$9,735,600	$4,514,346	$1,676,426
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	None	$0	$0	$0
31	2046	None	$0	$0	$0
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	Asphalt Light Rehab	$6,490,400	$2,447,051	$695,996
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	Asphalt Reconstruction	$34,615,467	$11,257,855	$2,646,590
40	2055	None	$0	$0	$0
41	2056	None	$0	$0	$0
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	None	$0	$0	$0
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Reconstruction	$17,307,733	$4,714,138	$881,767
Enter Year of Last Improvement ››		2054	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$54,955,186	$32,088,780
AGENCY COST	$90,865,600	

Project Description	Life-Cycle Cost Analysis for I-40 Corridor Profile Study: MP 3-8
Location #	I-40
Milepost Begin	3
Milepost End	8

	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehab Focus	Asphalt Light Rehab Focus
Net Present Value - 3%	$53,350,002	$60,304,011	$50,540,831	$54,955,186
Net Present Value - 7%	$38,710,901	$38,188,628	$28,728,347	$32,088,780
Agency Cost	$74,766,863	$98,437,733	$85,096,356	$90,865,600



Project Details	
Project Description	Life-Cycle Cost Analysis for I-40 Corridor Profile Study: MP 0-196
Location #	I-40, Segment 40-14
Milepost Begin	191
Milepost End	196

Roadway Characteristics			
Functional Classification	=	Interstate	
Surface Type	=	Concrete	‹‹Select from List
Traffic Directions	=	2	‹‹one-way or two-way traffic?
Number of Lanes [each direction]	=	2	
Width of Lanes (ft)	=	12	
Left shoulder width (ft)	=	4	
Right shoulder width (ft)	=	10	
Total Roadway Length (centerline miles)	=	5	
Current PSR Score	=	0	
Current Year	=	2015	
Roadway Width (ft) [each direction lanes & shoulders]	=	38	
Total Lane-Miles [Total traffic direction lanes & shoulders]	=	31.7	
Total Square Feet [Total traffic direction lanes & shoulders]	=	2,006,400	
Total Square Yards [Total traffic direction lanes & shoulders]	=	222,933	

LCCA Parameters		
Analysis Period (Years)	=	40
Year of Net Present Value	=	2016
First Year of Improvements	=	2020
Discount Rate (%) - Low	=	3%
Discount Rate (%) - High	=	7%
Number of Design Alternatives	=	6
Trigger Level for Rehabilitation (PSR)	=	3.4

Design Alternatives (DA)

Pavement Material Cost ($)

Treatment Type	Pavement Thickness	Typical Service Life	Lane-miles	Square Feet	Square Yards
Concrete Reconstruction	8"-12"	15-25	$350,000	$5.5	$50
Asphalt Reconstruction	8"-12"	10-20	$280,000	$4.4	$40
Concrete Medium Rehab	1"-3"	11-15	$75,000	$1.2	$11
Concrete Light Rehab	<1"	6-10	$50,000	$0.8	$7
Asphalt Medium Rehab	3"-8"	8-12	$105,000	$1.7	$15
Asphalt Light Rehab	<3"	3-7	$70,000	$1.1	$10

Reconstruction: Other Materials Cost Factor

1.60

Rehab: Other Materials Cost Factor

1.20

Total Cost Factor (e.g., includes design, mobilization, traffic control, contingency, e

2.44

Total Unit Cost ($) [includes material costs and indirect costs] **Total Bi-Direc**

Treatment Type	Pavement Thickness	Typical Service Life	Lane-miles	Square Feet	Square Yards
Concrete Reconstruction	8"-12"	12-20	$1,366,400	$21.6	$194
Asphalt Reconstruction	8"-12"	8-16	$1,093,120	$17.3	$155
Concrete Medium Rehab	1"-3"	9-12	$219,600	$3.5	$31
Concrete Light Rehab	<1"	4-8	$146,400	$2.3	$21
Asphalt Medium Rehab	3"-8"	6-10	$307,440	$4.9	$44
Asphalt Light Rehab	<3"	2-5	$204,960	$3.2	$29

		Concrete Reconstruction	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Concrete Reconstruction	$43,269,333	$38,444,242	$33,009,967
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	None	$0	$0	$0
14	2029	Concrete Light Rehab	$4,636,000	$3,156,890	$1,923,775
15	2030	None	$0	$0	$0
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	Concrete Medium Rehab	$6,954,000	$4,084,742	$2,057,438
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	None	$0	$0	$0
24	2039	None	$0	$0	$0
25	2040	None	$0	$0	$0
26	2041	Concrete Light Rehab	$4,636,000	$2,214,179	$854,179
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	None	$0	$0	$0
31	2046	Concrete Reconstruction	$43,269,333	$17,826,392	$5,684,168
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	None	$0	$0	$0
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	Concrete Light Rehab	$4,636,000	$1,463,833	$331,265
41	2056	None	$0	$0	$0
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	Concrete Medium Rehab	$6,954,000	$1,894,073	$354,281
Pick Last Improvement to calculate Remaining Service Life ››		Concrete Medium Rehab	$6,954,000	$1,894,073	$354,281
Enter Year of Last Improvement ››		2060	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$67,190,280	$43,860,792
AGENCY COST	$107,400,667	

		Asphalt Reconstruction	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Reconstruction	$34,615,467	$30,755,394	$26,407,974
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	Asphalt Light Rehab	$6,490,400	$4,688,803	$3,083,542
13	2028	None	$0	$0	$0
14	2029	None	$0	$0	$0
15	2030	None	$0	$0	$0
16	2031	Asphalt Medium Rehab	$9,735,600	$6,248,911	$3,528,629
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	None	$0	$0	$0
21	2036	None	$0	$0	$0
22	2037	Asphalt Light Rehab	$6,490,400	$3,488,910	$1,567,517
23	2038	None	$0	$0	$0
24	2039	None	$0	$0	$0
25	2040	None	$0	$0	$0
26	2041	Asphalt Reconstruction	$34,615,467	$16,532,540	$6,377,871
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	None	$0	$0	$0
31	2046	None	$0	$0	$0
32	2047	None	$0	$0	$0
33	2048	Asphalt Light Rehab	$6,490,400	$2,520,463	$744,716
34	2049	None	$0	$0	$0
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	Asphalt Medium Rehab	$9,735,600	$3,359,098	$852,210
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	None	$0	$0	$0
41	2056	None	$0	$0	$0
42	2057	None	$0	$0	$0
43	2058	Asphalt Light Rehab	$6,490,400	$1,875,461	$378,576
44	2059	None	$0	$0	$0
45	2060	None	$0	$0	$0
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Light Rehab	$2,163,467	$589,267	$110,221
Enter Year of Last Improvement ››		2058	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$68,880,312	$42,830,814
AGENCY COST	$112,500,267	

		Asphalt Medium Rehab Focus	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Medium Rehab	$9,735,600	$8,649,955	$7,427,243
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	None	$0	$0	$0
9	2024	None	$0	$0	$0
10	2025	Asphalt Light Rehab	$6,490,400	$4,974,351	$3,530,348
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	Asphalt Reconstruction	$34,615,467	$24,278,592	$15,369,681
14	2029	None	$0	$0	$0
15	2030	None	$0	$0	$0
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	Asphalt Light Rehab	$6,490,400	$3,701,384	$1,794,650
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	None	$0	$0	$0
24	2039	Asphalt Medium Rehab	$9,735,600	$4,932,948	$2,053,694
25	2040	None	$0	$0	$0
26	2041	None	$0	$0	$0
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	Asphalt Light Rehab	$6,490,400	$2,754,178	$912,309
31	2046	None	$0	$0	$0
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	Asphalt Reconstruction	$34,615,467	$13,050,939	$3,711,979
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	None	$0	$0	$0
41	2056	Asphalt Light Rehab	$6,490,400	$1,989,677	$433,431
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Enter Year of Last Improvement ››		2060	Remaining Service Life Cost ››		

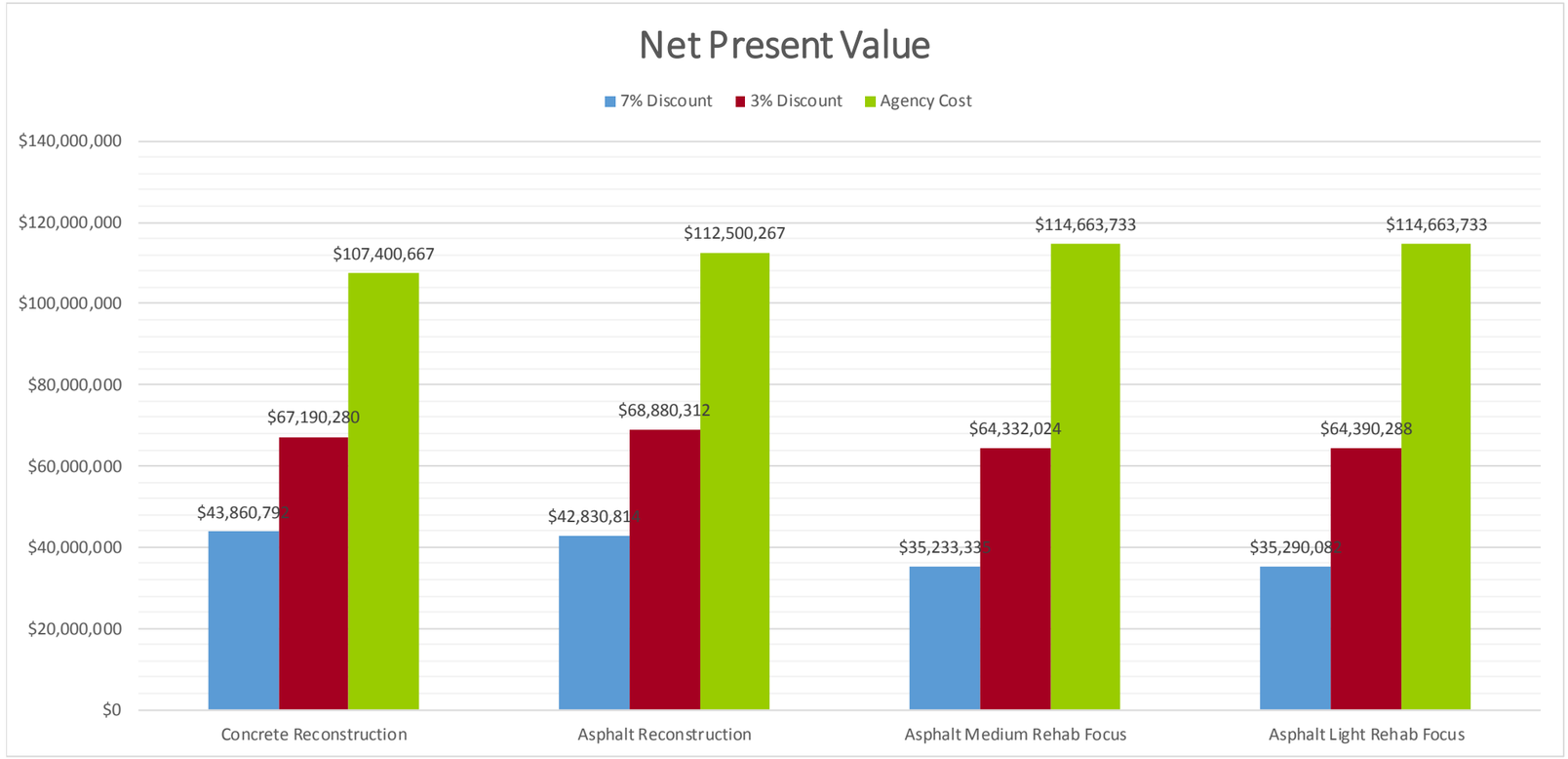
	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$64,332,024	$35,233,335
AGENCY COST	$114,663,733	

		Asphalt Light Rehab Focus	Agency Cost ($)	Net Present Value @ 3%	Net Present Value @ 7%
0	2015	None	$0	$0	$0
1	2016	None	$0	$0	$0
2	2017	None	$0	$0	$0
3	2018	None	$0	$0	$0
4	2019	None	$0	$0	$0
5	2020	Asphalt Light Rehab	$6,490,400	$5,766,636	$4,951,495
6	2021	None	$0	$0	$0
7	2022	None	$0	$0	$0
8	2023	Asphalt Medium Rehab	$9,735,600	$7,915,934	$6,062,842
9	2024	None	$0	$0	$0
10	2025	None	$0	$0	$0
11	2026	None	$0	$0	$0
12	2027	None	$0	$0	$0
13	2028	Asphalt Reconstruction	$34,615,467	$24,278,592	$15,369,681
14	2029	None	$0	$0	$0
15	2030	None	$0	$0	$0
16	2031	None	$0	$0	$0
17	2032	None	$0	$0	$0
18	2033	None	$0	$0	$0
19	2034	None	$0	$0	$0
20	2035	Asphalt Light Rehab	$6,490,400	$3,701,384	$1,794,650
21	2036	None	$0	$0	$0
22	2037	None	$0	$0	$0
23	2038	None	$0	$0	$0
24	2039	Asphalt Medium Rehab	$9,735,600	$4,932,948	$2,053,694
25	2040	None	$0	$0	$0
26	2041	None	$0	$0	$0
27	2042	None	$0	$0	$0
28	2043	None	$0	$0	$0
29	2044	None	$0	$0	$0
30	2045	Asphalt Light Rehab	$6,490,400	$2,754,178	$912,309
31	2046	None	$0	$0	$0
32	2047	None	$0	$0	$0
33	2048	None	$0	$0	$0
34	2049	Asphalt Reconstruction	$34,615,467	$13,050,939	$3,711,979
35	2050	None	$0	$0	$0
36	2051	None	$0	$0	$0
37	2052	None	$0	$0	$0
38	2053	None	$0	$0	$0
39	2054	None	$0	$0	$0
40	2055	None	$0	$0	$0
41	2056	Asphalt Light Rehab	$6,490,400	$1,989,677	$433,431
42	2057	None	$0	$0	$0
43	2058	None	$0	$0	$0
44	2059	None	$0	$0	$0
45	2060	Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Pick Last Improvement to calculate Remaining Service Life ››		Asphalt Medium Rehab	$9,735,600	$2,651,703	$495,994
Enter Year of Last Improvement ››		2060	Remaining Service Life Cost ››		

	Net Present Value ($) @ 3%	Net Present Value ($) @ 7%
NET PRESENT VALUE	$64,390,288	$35,290,082
AGENCY COST	$114,663,733	

Project Description	Life-Cycle Cost Analysis for I-40 Corridor Profile Study: MP 0-196
Location #	I-40, Segment 40-14
Milepost Begin	191
Milepost End	196

	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehab Focus	Asphalt Light Rehab Focus
Net Present Value - 3%	$67,190,280	$68,880,312	$64,332,024	$64,390,288
Net Present Value - 7%	$43,860,792	$42,830,814	$35,233,335	$35,290,082
Agency Cost	$107,400,667	$112,500,267	$114,663,733	$114,663,733



Appendix C Crash Modification Factors

SOLUTION	CONSTRUCTION COST	UNIT	FACTOR	TOTAL CONSTRUCTION COST	DESCRIPTION	CMF for Corridor Profile Studies	CMF Notes
REHABILITATION							
Rehabilitate Pavement (AC)	$270,000	Mile	2.20	$590,000	Mill and replace 1"-3" AC pvmt; accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, striping, RPMs, rumble strips	0.71	Avg of 3 values from clearinghouse; include striping, RPMs etc. 0.92 x 0.77 = 0.71
Rehabilitate Bridge	$65	SF	2.20	$140	Based on deck area; bridge only - no other costs included	0.95	Assumed - should have a minor effect on crashes at the bridge
GEOMETRIC IMPROVEMENT							
Re-profile Roadway	$968,000	Mile	2.20	$2,130,000	Includes excavation of approximately 3", pavement replacement (AC), striping, RPMs, rumble strips, for one direction of travel of 2-lane roadway (38' width)	0.8	Assumed - this is similar (but slightly conservative) to rehab pavement. This solution is intended to address vertical clearance at bridge, not profile issue.
Realign Roadway	$2,960,000	Mile	2.20	$6,510,000	All costs per direction except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.6	Based on CalTrans and NC DOT
Improve Skid Resistance	$668,500	Mile	2.20	$1,470,000	Average cost of pvmt replacement and variable depth paving to increase super-elevation; for one direction of travel on two lane roadway; includes pavement, striping, RPMs, rumble strips	0.67	Avg of 5 values from clearinghouse (0.77) and calculated value from HSM (0.87), times 0.77 to account for striping, RPMs, etc.
INFRASTRUCTURE IMPROVEMENT							
Construct Auxiliary Lanes (AC)	$914,000	Mile	2.20	$2,011,000	For addition of aux lane (AC) in one direction of travel; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.78	Average of 4 values from clearinghouse
Construct Climbing Lane (High)	$3,000,000	Mile	2.20	$6,600,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, steep slopes on both sides of road	0.75	From HSM
Construct Climbing Lane (Medium)	$2,250,000	Mile	2.20	$4,950,000	All costs except bridges; applicable to areas with medium or large fills and cuts, retaining walls, rock blasting, steep slopes on one side of road	0.75	From HSM
Construct Climbing Lane (Low)	$1,500,000	Mile	2.20	$3,300,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.75	From HSM

Construct Reversible Lane (Low)	$2,400,000	Lane-Mile	2.20	$5,280,000	All costs except bridges; applicable to areas with small or moderate fills and cuts, minimal retaining walls	0.70 for uphill and 0.85 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Reversible Lane (High)	$4,800,000	Lane-Mile	2.20	$10,560,000	All costs except bridges; applicable to areas with large fills and cuts, retaining walls, rock blasting, mountainous terrain	0.70 for uphill and 0.85 for downhill	Based on proposed conditions on I-17 with 2 reversible lanes and a conc barrier
Construct Entry/Exit Ramp	$730,000	Each	2.20	$1,610,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, typical earthwork & drainage; does not include any major structures or improvements on crossroad	1.09	Average of 16 values on clearinghouse; for adding a ramp not reconstructing
Modify Entry/Exit Ramp	$445,000	Each	2.20	$979,000	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting existing ramp to parallel-type configuration	0.21	Average of 4 values from clearinghouse (for exit ramps) and equation from HSM (for entrance ramp)
Widen & Modify Entry/Exit Ramp	$619,000	Each	2.20	$1,361,800	Cost per ramp; includes pavement, striping, signing, RPMs, lighting, minor earthwork, & drainage; For converting 1-lane ramp to 2-lane ramp and converting to parallel-type ramp	0.21	Will be same as "Modify Ramp"
Replace Pavement (AC)(with overexcavation)	$1,440,000	Mile	2.20	$3,170,000	Accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, overexcavation, striping, RPMs, rumble strips	0.71	Same as rehab
Replace Pavement (PCCP)(with overexcavation)	$1,730,000	Mile	2.20	$3,810,000	Accounts for 38' width; for one direction of travel on two lane roadway; includes pavement, overexcavation, striping, RPMs, rumble strips	0.71	Same as rehab
Replace Bridge	$125	SF	2.20	$280	Based on deck area; bridge only - no other costs included	0.95	Assumed - should have a minor effect on crashes at the bridge
Widen Bridge	$175	SF	2.20	$390	Based on deck area; bridge only - no other costs included	0.9	Assumed - should have a minor effect on crashes at the bridge
Implement Automated Bridge De-icing	$115	SF	2.20	$250	Includes cost to replace bridge deck and install system	0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
OPERATIONAL IMPROVEMENT							
Implement Variable Speed Limits (Wireless, Overhead)	$718,900	Mile	2.20	$1,580,000	Includes 2 signs per mile (foundations and structures), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Ground-mount)	$169,700	Mile	2.20	$373,300	Includes 2 signs per mile (foundations and posts), wireless communication, detectors	0.92	From 1 value from clearinghouse
Implement Variable Speed Limits (Wireless, Solar, Overhead)	$502,300	Mile	2.20	$1,110,000	Includes 2 signs per mile (foundations and structures), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse

Implement Variable Speed Limits (Wireless, Solar, Ground-mount)	$88,400	Mile	2.20	$194,500	Includes 2 signs per mile (foundations and posts), wireless communication, detectors, solar power	0.92	From 1 value from clearinghouse
Implement Ramp Metering (Low)	$25,000	Each	2.20	$55,000	For each entry ramp location; urban area with existing ITS backbone infrastructure; includes signals, poles, timer, pull boxes, etc	0.64	From 1 value from clearinghouse
Implement Ramp Metering (High)	$150,000	Mile	2.20	$330,000	Area without existing ITS backbone infrastructure; in addition to ramp meters, also includes conduit, fiber optic lines, and power	0.64	From 1 value from clearinghouse
Implement Shoulder Running (ATM components only)	$718,900	Mile	2.20	$1,581,600	Includes overhead signs, wireless communication, etc, but does not include shoulder widening	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
Implement Shoulder Running (ATM and shoulder widening)	$1,920,000	Mile	2.20	$4,224,000	Includes overhead signs, communication backbone, etc, and shoulder widening with pavement striping, striping, etc to widen by 10'	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
Implement Shoulder Running (ATM and shoulder widening in mountainous terrain)	$3,120,000	Mile	2.20	$6,864,000	Includes overhead signs, communication backbone, etc, and shoulder widening in mountainous terrain with pavement striping, striping, etc to widen by 10'	0.78	Combination of adding climbing lane & reducing shldr when active, and increasing shldr when not active
ROADSIDE DESIGN							
Install Guardrail	$130,000	Mile	2.20	$286,000	One side of road	0.62 (ROR)	0.62 is avg of 2 values from clearinghouse
Install Cable Barrier	$80,000	Mile	2.20	$176,000		0.81	0.81 is average of 5 values from clearinghouse
Widen Shoulder (AC)	$249,000	Mile	2.20	$548,000	Includes widening by a total of 4'; new pavement for 4' width and mill and replace existing 10' width; includes pavement, minor earthwork, striping edge lines, RPMs, and rumble strips	0.86 (1-4ft) 0.76 (4+ft)	0.86 is avg of 5 values from clearing house. 0.76 is calculated from HSM for >4 ft.
Rehabilitate Shoulder (AC)	$105,000	Mile	2.20	$231,000	One direction of travel (14' total shldr width); includes paving (mill and replace), rumble strips, RPMs, and striping of both shoulders	0.75	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, etc; = 0.98*0.77=0.75
Replace Shoulder (AC)	$357,000	Mile	2.20	$785,000	Accounts for 14' width; for one direction of travel; includes pavement, rumble strips, striping, RPMs	0.75	0.98 is average of 34 values on clearinghouse for shldr rehab/replace; include striping, etc; = 0.98*0.77=0.75
Install Rumble Strip	$5,500	Mile	2.20	$12,000	Both edges - one direction of travel; includes only rumble strip; no shoulder rehab or paving or striping	0.89	Average of 75 values on clearinghouse and consistent with HSM
Install Safety Edge	$80,000	Mile	2.20	$176,000		0.87	Average of 12 values on clearinghouse

Remove Tree/Vegetation	$200,000	Mile	2.20	$440,000		0.72 (snow/ice)	Average of 3 values on clearinghouse for snow/ice
ROADWAY DELINEATION							
Install High-Visibility Edge Line Striping	$10,800	Mile	2.20	$23,800	2 edge lines and lane line - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
Install High-Visibility Delineators	$6,500	Mile	2.20	$14,300	Both edges - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
Install Raised Pavement Markers	$2,000	Mile	2.20	$4,400	Both edges - one direction of travel	0.77	Avg of 3 values from clearinghouse. Assumes package of striping, delineators, and RPMs
IMPROVED VISIBILITY							
Cut Side Slopes	$80	Lin Ft	2.20	$200	For small grading to correct sight distance issues; not major grading	0.85	Intent of this solution is to improve sight distance. Most CMF's are associated with vehicles traveling on slope. Recommended CMF is based on FDOT and NCDOT but is more conservative.
Install Lighting (connect to existing power)	$270,000	Mile	2.20	$594,000	One side of road only; offset lighting, not high-mast; does not include power supply; includes poles, luminaire, pull boxes, conduit, conductor	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
Install Lighting (solar powered LED)	$10,000	Pole	2.20	$22,000	Offset lighting, not high-mast; solar power LED; includes poles, luminaire, solar panel	0.75 (night)	Average of 3 values on clearinghouse & consistent with HSM
DRIVER INFORMATION/WARNING							
Install Dynamic Message Sign (DMS)	$250,000	Each	2.20	$550,000	Includes sign, overhead structure, and foundations; wireless communication; does not include power supply	1	Not expected to reduce crashes
Install Dynamic Weather Warning Beacons	$40,000	Each	2.20	$88,000	Assumes solar operation and wireless communication or connection to existing power and communication; ground mounted; includes posts, foundations, solar panel, and dynamic sign	0.65 (weather related)	Avg of 3 values from HSM for dynamic/changeable warning signs
Install Speed Feedback Signs	$25,000	Each	2.20	$55,000	Assumes solar operation and no communication; ground mounted; includes regulatory sign, posts, foundations, solar panel, and dynamic sign	0.54	From HSM

Install Chevrons	$18,400	Mile	2.20	$40,500	On one side of road - includes signs, posts, and foundations	0.79	Average of 11 values on clearinghouse
Install Warning Signs	$2,500	Each	2.20	$5,500	Includes 2 signs, posts, and foundations	0.83	Average of 4 clearinghouse values
DATA COLLECTION							
Install Roadside Weather Information System (RWIS)	$60,000	Each	2.20	$132,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
Install Closed Circuit Television (CCTV) Camera	$25,000	Each	2.20	$55,000	Assumes connection to existing ITS backbone or wireless communication; does not include fiber-optic backbone infrastructure; includes pole, camera, etc	1.00	Not expected to reduce crashes
Install Vehicle Detection Stations	$15,000	Each	2.20	$33,000	Assumes wireless communication and solar power, or connection to existing power and communications	1.00	Not expected to reduce crashes
WIDEN CORRIDOR							
Construct New General Purpose Lane (PCCP)	$1,740,000	Mile	2.20	$3,830,000	For addition of 1 GP lane (PCCP) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.87
Construct New General Purpose Lane (AC)	$1,200,000	Mile	2.20	$2,640,000	For addition of 1 GP lane (AC) in one direction; includes all costs except bridges; for generally at-grade facility with minimal walls and no major drainage improvements	0.90	North Carolina DOT uses 0.90 and Florida DOT uses 0.88
ALTERNATE ROUTE							
Construct Frontage Roads	$2,400,000	Mile	2.20	$5,280,000	For 2-lane AC frontage road; includes all costs except bridges; for generally at-grade facility with minimal walls	0.9	Assumed - similar to new general purpose lane

Appendix D Performance Area Risk Factors

Pavement Performance Area

- Mainline Daily Traffic Volume
- Mainline Daily Truck Volume
- Elevation
- Interrupted Flow
-

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	< 6,000
0-5	6,000 – 160,000
5	>160,000

Mainline Daily Truck Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.00025)})$

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Bridge Performance Area

- Mainline Daily Traffic Volume
- Detour Length
- Elevation
- Scour Critical Rating
- Carries Mainline Traffic
- Vertical Clearance

Mainline Daily Traffic Volume

Exponential equation; score = $5-(5*e^{(ADT*-0.000039)})$

Score	Condition
0	<6,0000
0-5	6,000-160,000
5	>160,000

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Carries Mainline

Score	Condition
0	Does not carry mainline traffic
5	Carries mainline traffic

Detour Scale

Divides detour length by 10 and multiplies by 2.5

Score	Condition
0	0 miles
0-5	0-20 miles
5	> 20 miles

Scour

Variance below 8

Score	Condition
0	Rating > 8
0-5	Rating 8 - 3
5	Rating < 3

Vertical Clearance

Variance below 16’ x 2.5; (16 –Clearance) x 2.5

Score	Condition
0	>16’
0-5	16’-14’
5	<14’

Mobility Performance Area

- Mainline VMT
- Detour Length
- Buffer Index (PTI-TTI)
  -

Mainline VMT

Exponential equation; score = 5-(5*$e^{(ADT*-0.0000139)}$)

Score	Condition
0	<16,000
0-5	16,000-400,000
5	>400,000

Buffer Index

Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Safety Performance Area

- Mainline Daily Traffic Volume
- Vertical Grade
- Shoulder width (Right)
- Elevation
- Interrupted Flow

Mainline Daily Traffic Volume

Exponential equation; score = 5-(5*$e^{(ADT*-0.000039)}$)

Score	Condition
0	<6,000
0-5	6,000-160,000
5	>160,000

Interrupted Flow

Score	Condition
0	Not interrupted flow
5	Interrupted Flow

Elevation

Variance above 4000' divided by 1000; (Elev-4000)/1000

Score	Condition
0	< 4000’
0-5	4000’- 9000’
5	> 9000’

Shoulder (Right side)

Variance below 10'

Score	Condition
0	10’ or above
0-5	10’ - 5’
5	5’ or less

Grade

Variance above 3% x 1.5

Score	Condition
0	< 3%
0-5	3% - 6.33%
5	>6.33%

Freight Performance Area

- Mainline Daily Truck Volume
- Detour Length
- Truck Buffer Index (TPTI-TTTI)
  -

Mainline Daily Truck Volume

Exponential equation; score = 5-(5*$e^{(ADT*-0.00025)}$)

Score	Condition
0	<900
0-5	900-25,000
5	>25,000

Detour Length

Score	Condition
0	Detour < 10 miles
5	Detour > 10 miles

Truck Buffer Index

Truck Buffer Index x 10

Score	Condition
0	Buffer Index = 0.00
0-5	Buffer Index 0.00-0.50
5	Buffer Index > 0.50

Performance Area Risk Factors Input

Solution Number	Mainline Traffic Vol (vpd) (2-way)	Solution Length (miles)	Bridge Detour Length (miles) (N19)	Elevation (ft)	Scour Critical Rating (0-9)	Carries Mainline Traffic (Y/N)	Bridge Vert. Clear (ft)	Mainline Truck Vol (vpd) (2-way)	Detour Length > 10 miles (Y/N)	Truck Buffer Index	Non-Truck Buffer Index	Grade (%)	Interrupted Flow (Y/N)	Outside/ Right Shoulder Width (ft)
1	13,028	0	6	525	8	Y	16.00	4,330	N	0.16	0.25			
2	13,028	5		858				4,330	N	0.16	0.25		N	
3	13,028	11		757				4,330	N	0.16	0.25		N	
4	13,475	0	1	1,155	7	Y	16.00	5,134	N	0.11	0.15			
5	13,475	0	1	1,434	8	Y	16.00	5,134	N	0.11	0.15			
6	13,475	0	1	1,587	7	Y	16.00	5,134	N	0.11	0.15			
7	13,475	0	1	2,606	7	Y	16.00	5,134	N	0.11	0.15			
8	13,475	32		1,911				5,134	N	0.11	0.15		N	
9	20,993	12		3,192				5,851	N	0.24	0.46		N	
10	17,157	19		3,558				5,034	N	0.30	0.46	1.5	N	10
11	11,874	18		4,715				3,171	N	0.19	0.29	2.0	N	10
12	12,890	10		5,500				3,289	N	0.12	0.16	0.7	N	10
13	13,704	0	9	5,715	8	N	17.51	3,593	N	0.11	0.18			
14	14,356	0	1	5,307	7	Y	16.00	3,966	N	0.41	0.58			
15	14,356	17		6,034				3,966	N	0.41	0.58	2.4	N	10
16	15,774	8		7,010				4,253	N	0.18	0.24	1.4	N	10
17	27,415	5		7,157				4,424	N	0.14	0.19	1.7	N	10
18	27,415	0	0	7,239	8	Y	14.90	4,424	N	0.14	0.19			
19	27,415	0	0	7,102	8	Y	16.85	4,424	N	0.14	0.19			
20	27,415	0	1	7,131	8	Y	16.27	4,424	N	0.14	0.19			

Performance Area Risk Factors Calculations

Solution Number	Bridge	Pavement	Mobility	Safety	Freight	Bridge		Pavement		Mobility		Safety		Freight	
						Standard Risk Score (0 to 10)	Weighted Risk Score (0 to 10)	Standard Risk Score (0 to 10)	Weighted Risk Score (0 to 10)	Standard Risk Score (0 to 10)	Weighted Risk Score (0 to 10)	Standard Risk Score (0 to 10)	Weighted Risk Score (0 to 10)	Standard Risk Score (0 to 10)	Weighted Risk Score (0 to 10)
CS 40.1	Y	N	Y	N	Y	3.33	3.33	0.00	0.00	1.67	1.67	0.00	0.00	3.28	3.28
CS 40.2	N	Y	Y	Y	Y	0.00	0.00	3.53	3.53	3.65	3.65	2.79	2.79	3.28	3.28
CS 40.3	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	4.54	4.54	2.79	2.79	3.28	3.28
CS 40.4	Y	N	Y	N	Y	2.84	2.84	0.00	0.00	1.00	1.00	0.00	0.00	3.15	3.15
CS 40.5	Y	N	Y	N	Y	2.51	2.51	0.00	0.00	1.00	1.00	0.00	0.00	3.15	3.15
CS 40.6	Y	N	Y	N	Y	2.84	2.84	0.00	0.00	1.00	1.00	0.00	0.00	3.15	3.15
CS 40.7	Y	N	Y	N	Y	2.84	2.84	0.00	0.00	1.00	1.00	0.00	0.00	3.15	3.15
CS 40.8	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	4.32	4.32	2.81	2.81	3.15	3.15
CS 40.9	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	6.30	6.30	3.11	3.11	4.17	4.17
CS 40.10	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	6.36	6.36	0.97	0.97	4.39	4.39
CS 40.11	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	5.10	5.10	1.02	1.02	3.10	3.10
CS 40.12	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	3.84	3.84	1.38	1.38	2.68	2.68
CS 40.13	Y	N	Y	N	Y	2.76	2.76	0.00	0.00	1.20	1.20	0.00	0.00	2.72	2.72
CS 40.14	Y	N	Y	N	Y	3.31	3.31	0.00	0.00	3.33	3.33	0.00	0.00	4.84	4.84
CS 40.15	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	6.55	6.55	1.66	1.66	4.84	4.84
CS 40.16	N	N	Y	Y	Y	0.00	0.00	0.00	0.00	4.36	4.36	2.12	2.12	3.39	3.39
CS 40.17	N	Y	Y	Y	Y	0.00	0.00	6.52	6.52	4.10	4.10	2.57	2.57	3.17	3.17
CS 40.18	Y	N	Y	N	Y	4.75	4.75	0.00	0.00	1.27	1.27	0.00	0.00	3.17	3.17
CS 40.19	Y	N	Y	N	Y	3.79	3.79	0.00	0.00	1.27	1.27	0.00	0.00	3.17	3.17
CS 40.20	Y	N	Y	N	Y	2.76	2.76	0.00	0.00	1.27	1.27	0.00	0.00	3.17	3.17

Appendix E Performance Effectiveness Scores

Post-Project Performance Scores

Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
Description	Replace Bridge/ Widen Shoulder	Replace Pavement	Safety Improvements	Replace Bridge	Replace Bridge	Replace Bridge	Replace Bridge	Safety Improvements	Safety and Mobility Improvements	Safety Improvements	Safety Improvements	Safety Improvements	Replace Bridge	Safety Improvements	Safety Improvements	Replace Pavement
Project Beg MP	0	3	0	13	18	21	40	11	43	58	80	98	110	143	160	191
Project End MP	0	8	11	13	18	21	40	43	55	71	88	108	110	160	168	196
Project Length (miles)	0	5	11	0	0	0	0	32	12	13	8	10	0	17	8	5
Segment Beg MP	0	0	0	11	11	11	11	11	43	55	80	98	108	143	160	190
Segment End MP	11	11	11	43	43	43	43	43	55	74	98	108	120	160	168	196
Segment Length (miles)	11	11	11	32	32	32	32	32	12	19	18	10	12	17	8	6
Segment #	1	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**4**	**6**	**7**	**8**	**10**	**11**	**14**
Current # of Lanes (both directions)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Project Type (one-way or two-way)	two-way	two-way	two-way	one-way	one-way	one-way	one-way	two-way	two-way	two-way	one-way	two-way	two-way	two-way	two-way	two-way
Additional Lanes (one-way)	0	0	0	0	0	0	0	0	0.33	0.11	0.39	0.00	0.00	0.24	0.125	0
Pro-Rated # of Lanes	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.33	4.11	4.17	4.00	4.00	4.24	4.13	4.00
Description																
SAFETY / **DIRECTIONAL SAFETY**																
Orig Segment Directional Safety Index (direction 1)	1.337	1.337	1.337	1.193	1.193	1.193	1.193	1.193	1.468	1.461	1.361	1.519	0.274	1.224	0.922	0.596
Orig Segment Directional Fatal Crashes (direction 1)	2	2	2	5	5	5	5	5	4	4	3	2	0	3	1	1
Orig Segment Directional Incap Crashes (direction 1)	3	3	3	14	14	14	14	14	8	9	7	3	7	4	3	1
Original Fatal Crashes in project limits (direction 1)	0	2	2	0	0	0	0	5	4	3	3	2	0	3	1	0
Original Incap Crashes in project limits (direction 1)	0	2	3	0	0	0	0	14	8	6	3	3	0	4	3	1
CMF 1 (direction 1)	0.95	0.71	0.75	1	0.95	1	1	0.75	0.75	0.75	0.75	0.75	0.95	0.75	0.75	0.71
CMF 2 (direction 1)	0.76	1	0.77	1	1	1	1	0.77	0.77	0.92	0.92	0.77	1	0.77	0.77	1
CMF 3 (direction 1)	1	1	1	1	1	1	1	1	0.92	1	1	0.92	1	0.75	0.92	1
Total CMF (direction 1)	0.722	0.710	0.578	1.000	0.950	1.000	1.000	0.578	0.430	0.690	0.690	0.531	0.950	0.398	0.531	0.710
Fatal Crash reduction (direction 1)	0.000	0.580	0.845	0.000	0.000	0.000	0.000	2.113	2.279	0.930	0.930	0.937	0.000	1.805	0.469	0.000
Incap Crash reduction (direction 1)	0.000	0.580	1.268	0.000	0.000	0.000	0.000	5.915	4.557	1.860	0.930	1.406	0.000	2.406	1.406	0.290
Post-Project Segment Directional Fatal Crashes (direction 1)	2.000	1.420	1.155	5.000	5.000	5.000	5.000	2.888	1.721	3.070	2.070	1.063	0.000	1.195	0.531	1.000
Post-Project Segment Directional Incap Crashes (direction 1)	3.000	2.420	1.733	14.000	14.000	14.000	14.000	8.085	3.443	7.140	6.070	1.594	7.000	1.594	1.594	0.710

		Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
		Post-Project Segment Directional Safety Index (direction 1)	1.337	0.961	0.770	1.262	1.262	1.262	1.262	0.689	0.632	1.127	0.972	0.807	0.274	0.488	0.490	0.585
		Orig Segment Directional Safety Index (direction 2)	1.354	1.354	1.354	0.810	0.810	0.810	0.810	0.810	1.060	2.036	1.813	0.878	0.239	2.964	0.934	0.039
		Orig Segment Directional Fatal Crashes (direction 2)	2	2	2	3	3	3	3	3	3	6	4	1	0	7	1	0
		Orig Segment Directional Incap Crashes (direction 2)	3	3	3	15	15	15	15	15	4	6	8	4	6	11	3	1
		Original Fatal Crashes in project limits (direction 2)	0	0	2	0	0	0	0	3	3	1	4	1	0	7	1	0
		Original Incap Crashes in project limits (direction 2)	0	3	3	0	0	0	0	15	4	5	8	4	0	11	3	1
		CMF 1 (direction 2)	0.95	0.71	0.75	0.95	1	0.95	0.95	0.75	0.75	0.92	1	0.75	0.95	0.75	0.75	0.71
		CMF 1 (direction 2)	0.76	1	0.77	1	1	1	1	0.77	0.77	1	1	0.77	1	0.77	0.77	1
		CMF 1 (direction 2)	1	1	1	1	1	1	1	1	0.92	1	1	0.92	1	0.92	0.75	1
		Total CMF (direction 2)	0.722	0.710	0.578	0.950	1.000	0.950	0.950	0.578	0.430	0.920	1.000	0.531	0.950	0.531	0.398	0.710
		Fatal Crash reduction (direction 2)	0.000	0.000	0.845	0.000	0.000	0.000	0.000	1.268	1.709	0.080	0.000	0.469	0.000	3.281	0.602	0.000
		Incap Crash reduction (direction 2)	0.000	0.870	1.268	0.000	0.000	0.000	0.000	6.338	2.279	0.400	0.000	1.875	0.000	5.156	1.805	0.290
		Post-Project Segment Directional Fatal Crashes (direction 2)	2.000	2.000	1.155	3.000	3.000	3.000	3.000	1.733	1.291	5.920	4.000	0.531	0.000	3.719	0.398	0.000
		Post-Project Segment Directional Incap Crashes (direction 2)	3.000	2.130	1.733	15.000	15.000	15.000	15.000	8.663	1.721	5.600	8.000	2.125	6.000	5.844	1.195	0.710
		Post-Project Segment Directional Safety Index (direction 2)	1.354	1.317	0.780	0.810	0.810	0.810	0.810	0.468	0.456	2.002	1.813	0.466	0.239	1.575	0.372	0.027
		Current Safety Index	1.346	1.346	1.346	1.002	1.002	1.002	1.002	1.002	1.264	1.749	1.587	1.199	0.257	2.094	0.928	0.317
		Post-Project Safety Index	1.346	1.139	0.775	1.036	1.036	1.036	1.036	0.579	0.544	1.565	1.393	0.637	0.257	1.032	0.431	0.306
	Needs	Original Segment Safety Need	3.152	3.152	3.152	2.231	2.231	2.231	2.231	2.231	2.627	4.496	3.457	2.12	0.169	5.147	1.223	0.205
	Needs	Post-Project Segment Safety Need	3.152	2.428	1.011	2.231	2.231	2.231	2.231	1.381	0.351	3.883	2.777	0.42	0.169	1.489	0.784	0.197
MOBILITY	**MOBILITY INDEX**	Original Segment Mobility Index	0.280	0.280	0.280	0.290	0.290	0.290	0.290	0.290	0.410	0.190	0.250	0.270	0.290	0.310	0.320	0.510
MOBILITY	**MOBILITY INDEX**	Post-Project # of Lanes (both directions)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.3333	4.1053	4.1728	4.00	4.00	4.2353	4.1250	4.00
MOBILITY	**MOBILITY INDEX**	Post-Project Segment Mobility Index									0.370	0.190	0.240	0.270		0.290	0.320	
MOBILITY	**FUT V/C**	Original Segment Future V/C	0.390	0.390	0.390	0.400	0.400	0.400	0.400	0.400	0.530	0.160	0.340	0.370	0.400	0.430	0.440	0.670
MOBILITY	**FUT V/C**	Post-Project Segment Future V/C	-	-	-	-	-	-	-	-	0.490	0.150	0.330	0.370	-	0.400	0.430	-
MOBILITY	**PEAK HOUR V/C**	Original Segment Peak Hour V/C (direction 1)	0.180	0.180	0.180	0.190	0.190	0.190	0.190	0.190	0.270	0.190	0.130	0.150	0.160	0.130	0.140	0.270
MOBILITY	**PEAK HOUR V/C**	Original Segment Peak Hour V/C (direction 2)	0.180	0.180	0.180	0.190	0.190	0.190	0.190	0.190	0.270	0.190	0.120	0.150	0.150	0.130	0.140	0.270
MOBILITY	**PEAK HOUR V/C**	Adjusted total # of Lanes for use in directional peak hr	0.00	0.00	0.00	4.00	4.00	4.00	4.00	0.00	0.00	0.00	4.35	0.00	0.00	0.00	0.00	0.00

		Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
		Post-Project Segment Peak Hr V/C (direction 1)	-	-	-	-	-	-	-	-	0.230	0.170	0.120	0.130	-	0.120	0.130	-
		Post-Project Segment Peak Hr V/C (direction 2)	-	-	-	-	-	-	-	-	0.240	0.170	0.100	0.130	-	0.110	0.120	-
	TTI AND PTI	Safety Reduction Factor	1.000	0.719	0.576	1.058	1.058	1.058	1.058	0.578	0.430	0.771	0.714	0.531	0.999	0.399	0.531	0.981
		Safety Reduction	0.000	0.281	0.424	-0.058	-0.058	-0.058	-0.058	0.422	0.570	0.229	0.286	0.469	0.001	0.601	0.469	0.019
		Mobility Reduction Factor	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.902	1.000	0.960	1.000	0.000	0.935	1.000	0.000
		Mobility Reduction	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.098	0.000	0.040	0.000	1.000	0.065	0.000	1.000
		Mobility effect on TTI	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Mobility effect on PTI	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		Safety effect on TTI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Safety effect on PTI	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Original Directional Segment TTI (direction 1)	1.232	1.232	1.232	1.120	1.120	1.120	1.120	1.120	1.217	1.163	1.242	1.127	1.092	1.313	1.156	1.042
		Original Directional Segment PTI (direction 1)	1.556	1.556	1.556	1.292	1.292	1.292	1.292	1.292	1.725	1.692	1.637	1.312	1.231	1.980	1.399	1.202
		Original Directional Segment TTI (direction 2)	1.100	1.100	1.100	1.089	1.089	1.089	1.089	1.089	1.143	1.153	1.097	1.085	1.144	1.163	1.123	1.136
		Original Directional Segment PTI (direction 2)	1.275	1.275	1.275	1.217	1.217	1.217	1.217	1.217	1.561	1.544	1.275	1.217	1.367	1.653	1.363	1.361
		Reduction Factor for Segment TTI	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.029	0.000	0.012	0.000	0.300	0.019	0.000	0.300
		Reduction Factor for Segment PTI	0.200	0.284	0.327	0.183	0.183	0.183	0.183	0.327	0.190	0.069	0.094	0.141	0.200	0.193	0.141	0.206
		Post-Project Directional Segment TTI (direction 1)	0.862	0.862	0.862	0.784	0.784	0.784	0.784	0.784	1.217	1.163	1.227	1.127	0.764	1.288	1.156	0.729
		Post-Project Directional Segment PTI (direction 1)	1.245	1.114	1.047	1.056	1.056	1.056	1.056	0.870	1.725	1.692	1.484	1.127	0.984	1.597	1.399	0.955
		Post-Project Directional Segment TTTI (direction 2)	1.050	1.050	1.050	1.089	1.089	1.089	1.089	1.045	1.143	1.153	1.097	1.085	1.072	1.140	1.123	1.068
		Post-Project Directional Segment TPTI (direction 2)	1.020	1.138	1.138	1.217	1.217	1.217	1.217	1.109	1.561	1.544	1.275	1.046	1.093	1.333	1.363	1.081
	CLOSURE EXTENT	Orig Segment Directional Closure Extent (direction 1)	0.145	0.145	0.145	0.163	0.163	0.163	0.163	0.163	0.283	0.371	1.199	1.060	1.067	0.714	0.550	0.533
		Orig Segment Directional Closure Extent (direction 2)	0.055	0.055	0.055	0.088	0.088	0.088	0.088	0.088	0.117	0.168	0.122	0.000	0.117	0.586	0.300	0.133
		Segment Closures with fatalities/injuries	5	5	5	21	21	21	21	21	10	13	10	4	6	7	2	4
		Total Segment Closures	12	12	12	38	38	38	38	38	24	35	21	9	15	21	10	9
		% Closures with Fatality/Injury	0.42	0.42	0.42	0.55	0.55	0.55	0.55	0.55	0.42	0.37	0.48	0.44	0.40	0.33	0.20	0.44
		Closure Reduction	0.000	0.117	0.177	-0.032	-0.032	-0.032	-0.032	0.233	0.237	0.085	0.136	0.208	0.001	0.200	0.094	0.008
		Closure Reduction Factor	1.000	0.883	0.823	1.032	1.032	1.032	1.032	0.767	0.763	0.915	0.864	0.792	0.999	0.800	0.906	0.992
		Post-Project Segment Directional Closure Extent (direction 1)	0.145	0.128	0.120	0.168	0.168	0.168	0.168	0.125	0.283	0.371	1.036	0.839	1.066	0.571	0.550	0.529

		Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
		Post-Project Segment Directional Closure Extent (direction 2)	0.055	0.049	0.045	0.091	0.091	0.091	0.091	0.067	0.117	0.168	0.105	0.000	0.117	0.469	0.300	0.132
	Needs	Original Segment Mobility Need	0.716	0.716	0.716	0.983	0.983	0.983	0.983	0.983	1.275	0.967	1.206	0.847	0.892	1.868	0.807	0.902
	Needs	Post-Project Segment Mobility Need	0.456	0.453	0.449	0.962	0.962	0.962	0.962	0.94	1.23	0.962	0.991	0.748	0.856	1.166	0.803	0.867
FREIGHT	**TTTI AND TPTI**	Mobility effect on TTTI	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Mobility effect on TPTI	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
		Safety effect on TTTI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Safety effect on TPTI	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Original Directional Segment TTTI (direction 1)	1.121	1.121	1.121	1.047	1.047	1.047	1.047	1.047	1.135	1.114	1.154	1.073	1.021	1.229	1.078	1.032
		Original Directional Segment TPTI (direction 1)	1.329	1.329	1.329	1.161	1.161	1.161	1.161	1.161	1.468	1.482	1.421	1.205	1.113	1.694	1.259	1.145
		Original Directional Segment TTTI (direction 2)	1.060	1.060	1.060	1.032	1.032	1.032	1.032	1.032	1.044	1.103	1.026	1.025	1.072	1.094	1.059	1.098
		Original Directional Segment TPTI (direction 2)	1.173	1.173	1.173	1.130	1.130	1.130	1.130	1.130	1.181	1.333	1.147	1.126	1.191	1.455	1.228	1.269
		Reduction Factor for Segment TTTI (both directions)	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.015	0.000	0.006	0.000	0.150	0.010	0.000	0.150
		Reduction Factor for Segment TPTI (both directions)	0.100	0.142	0.164	0.091	0.091	0.091	0.091	0.163	0.095	0.034	0.047	0.070	0.100	0.097	0.070	0.103
		Post-Project Directional Segment TTTI (direction 1)	1.037	1.037	1.037	0.968	0.968	0.968	0.968	0.968	1.118	1.114	1.147	1.073	0.944	1.217	1.078	0.955
		Post-Project Directional Segment TPTI (direction 1)	1.196	1.140	1.112	1.055	1.055	1.055	1.055	1.066	1.328	1.431	1.354	1.120	1.001	1.530	1.170	1.027
		Post-Project Directional Segment TTTI (direction 2)	1.030	1.030	1.030	1.032	1.032	1.032	1.032	1.016	1.029	1.103	1.026	1.025	1.036	1.083	1.059	1.049
		Post-Project Directional Segment TPTI (direction 2)	1.056	1.006	1.087	1.130	1.130	1.130	1.130	1.065	1.069	1.287	1.147	1.047	1.072	1.314	1.142	1.139
	FREIGHT INDEX	Original Segment TPTI (direction 1)	1.329	1.329	1.329	1.161	1.161	1.161	1.161	1.161	1.468	1.482	1.421	1.205	1.113	1.694	1.259	1.145
	FREIGHT INDEX	Original Segment TPTI (direction 2)	1.173	1.173	1.173	1.130	1.130	1.130	1.130	1.130	1.181	1.333	1.147	1.126	1.191	1.455	1.228	1.269
	FREIGHT INDEX	Original Segment Freight Index	0.799	0.799	0.799	0.873	0.873	0.873	0.873	0.873	0.755	0.710	0.779	0.858	0.868	0.635	0.804	0.828
	FREIGHT INDEX	Post-Project Segment TPTI (direction 1)	1.196	1.140	1.112	1.055	1.055	1.055	1.055	1.066	1.328	1.431	1.354	1.120	1.001	1.530	1.170	1.027
	FREIGHT INDEX	Post-Project Segment TPTI (direction 2)	1.056	1.006	1.087	1.130	1.130	1.130	1.130	1.065	1.069	1.287	1.147	1.047	1.072	1.314	1.142	1.139
	FREIGHT INDEX	Post-Project Segment Freight Index	0.888	0.932	0.910	0.915	0.915	0.915	0.915	0.938	0.834	0.736	0.800	0.923	0.965	0.703	0.865	0.923
	CLOSURE DURATION	Orig Segment Directional Closure Duration (dir 1)	23.109	23.109	23.109	42.106	42.106	42.106	42.106	42.106	51.267	154.412	686.314	641.440	637.783	374.772	202.700	204.267
	CLOSURE DURATION	Orig Segment Directional Closure Duration (dir 2)	9.818	9.818	9.818	22.212	22.212	22.212	22.212	22.212	17.517	24.211	46.589	0.000	15.950	491.318	285.300	34.333

		Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
BRIDGE		Segment Closures with fatalities	5	5	5	21	21	21	21	21	10	13	10	4	6	7	2	4
		Total Segment Closures	12	12	12	38	38	38	38	38	24	35	21	9	15	21	10	9
		% Closures with Fatality	0.42	0.42	0.42	0.55	0.55	0.55	0.55	0.55	0.42	0.37	0.48	0.44	0.40	0.33	0.20	0.44
		Closure Reduction	0.000	0.117	0.177	-0.032	-0.032	-0.032	-0.032	0.233	0.237	0.085	0.136	0.208	0.001	0.200	0.094	0.008
		Closure Reduction Factor	1.000	0.883	0.823	1.032	1.032	1.032	1.032	0.767	0.763	0.915	0.864	0.792	0.999	0.800	0.906	0.992
		Post-Project Segment Directional Closure Duration (direction 1)	23.110	20.402	19.026	43.452	43.452	43.452	43.452	32.276	39.101	141.289	592.970	507.787	637.454	299.636	183.695	202.557
		Post-Project Segment Directional Closure Duration (direction 2)	9.818	8.668	8.083	22.212	22.212	22.212	22.212	17.026	13.360	22.153	46.589	0.000	15.942	392.816	258.551	34.046
	VERT CLR	Original Vertical Clearance	16.17	16.17	16.17	16.14	16.14	16.14	16.14	16.14	16.25	16.25	16.00	16.65	16.17	16.27	16.20	16.27
		Post-Project Vertical Clearance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Needs	Original Segment Freight Need	0.506	0.506	0.506	0.531	0.531	0.531	0.531	0.531	0.914	2.087	2.11	1.341	1.635	4.874	1.285	0.725
		Post-Project Segment Freight Need	0.487	0.48	0.481	0.525	0.525	0.525	0.525	0.511	0.415	1.252	1.704	1.086	1.621	3.279	1.193	0.707
	BRIDGE INDEX	Original Segment Bridge Index	3.66	NO CHANGE	NO CHANGE	5.78	5.78	5.78	5.78	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	5.71	NO CHANGE	NO CHANGE	NO CHANGE
		Original lowest rating for specific bridge	3.00	NO CHANGE	NO CHANGE	5	4	5	4	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	4	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project lowest rating for specific bridge	8.00	NO CHANGE	NO CHANGE	8	8	8	8	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	8	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Bridge Index	7.56	NO CHANGE	NO CHANGE	5.86	5.84	5.85	5.87	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	6.78	NO CHANGE	NO CHANGE	NO CHANGE
	SUFF RATING	Original Segment Sufficiency Rating	81.10	NO CHANGE	NO CHANGE	90.49	90.49	90.49	90.49		NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	90.38	NO CHANGE	NO CHANGE	NO CHANGE
		Original Sufficiency Rating for specific bridge	78.00	NO CHANGE	NO CHANGE	75.09	67.12	77.76	67.39	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	85.92	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Sufficiency Rating for specific bridge	98.00	NO CHANGE	NO CHANGE	98.00	98.00	98.00	98.00	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	98.00	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Segment Sufficiency Rating	96.68	NO CHANGE	NO CHANGE	91.10	90.91	90.96	91.19	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	93.62	NO CHANGE	NO CHANGE	NO CHANGE
	BR RTNG	Original Segment Bridge Rating	3	NO CHANGE	NO CHANGE	4	4	4	4	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	4	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Segment Bridge Rating	6	NO CHANGE	NO CHANGE	4	4	4	4	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	8	NO CHANGE	NO CHANGE	NO CHANGE
	% FUN OB	Original Segment % Functionally Obsolete	5.75%	NO CHANGE	NO CHANGE	5.92%	5.92%	5.92%	5.92%	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	49.00%	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Segment % Functionally Obsolete	5.75%	NO CHANGE	NO CHANGE	5.92%	5.92%	5.92%	5.92%	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	49.00%	NO CHANGE	NO CHANGE	NO CHANGE
	Needs	Original Segment Bridge Need	3.200	NO CHANGE	NO CHANGE	1.250	1.250	1.250	1.250	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	1.640	NO CHANGE	NO CHANGE	NO CHANGE
		Post-Project Segment Bridge Need	0.014	NO CHANGE	NO CHANGE	1.094	1.134	1.114	1.074	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0.550	NO CHANGE	NO CHANGE	NO CHANGE
PAVEMENT	PAVEMENT	Original Segment Pavement Index	NO CHANGE	4.10	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.73

		Candidate Solution #	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	40.10	40.11	40.12	40.13	40.15	40.16	40.17
		Original Segment IRI in project limits	NO CHANGE	53-84	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	50-118
		Original Segment Cracking in project limits	NO CHANGE	2-20	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0-6
		Post-Project IRI in project limits	NO CHANGE	30	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	30
		Post-Project Cracking in project limits	NO CHANGE	0	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0
		Post-Project Pavement Index	NO CHANGE	4.51	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	4.21
	DIRECTION PSR	Original Segment Directional PSR (direction 1)	NO CHANGE	4.03	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	3.87
		Original Segment Directional PSR (direction 2)		4.12														3.73
		Original Segment IRI in project limits	NO CHANGE	53-84	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	50-118
		Post-Project directional IRI in project limits	NO CHANGE	30	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	30
		Post-Project Directional PSR (direction 1)		4.34														4.23
		Post-Project Directional PSR (direction 2)	NO CHANGE	4.36	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	4.31
	% FAIL	Original Segment % Failure	NO CHANGE	5.0%	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	28.0%
		Post-Project Segment % Failure	NO CHANGE	0.0%	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	16.0%
	Needs	Original Segment Pavement Need	NO CHANGE	0.045	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0.647
		Post-Project Segment Pavement Need	NO CHANGE	0.000	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	0.320

Performance Area Scores

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement					Bridge					Safety					Mobility					Freight					Total Performance Area Score
				Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	
CS 40.1	Colorado River Bridge #957	0-0	55.00			0.00		0.000	3.2	0.014	3.19	3.33	10.609	3.152	3.152	0.00		0.000	0.716	0.456	0.260	1.67	0.434	0.506	0.487	0.019	3.28	0.062	11.106
CS 40.2	Topock Area Pavement Improvements Option B - Replacement	3-8	42.90	0.045	0	0.05	3.53	0.159			0.00		0.000	3.152	2.428	0.72	2.79	2.020	0.716	0.453	0.263	3.65	0.960	0.506	0.48	0.026	3.28	0.085	3.224
CS 40.3	Stateline to SR-95 Safety Improvements	0-11	6.10			0.00		0.000			0.00		0.000	3.152	1.011	2.14	2.79	5.973	0.716	0.449	0.267	4.54	1.212	0.506	0.481	0.025	3.28	0.082	7.268
CS 40.4	Franconia Wash WB Bridge #377 Option B - Replacement	13-13	2.26			0.00		0.000	1.25	1.094	0.16	2.84	0.443	2.231	2.231	0.00		0.000	0.983	0.962	0.021	1.00	0.021	0.531	0.525	0.006	3.15	0.019	0.483
CS 40.5	Illavar Wash EB Bridge #1310 Option B - Replacement	18-18	1.24			0.00		0.000	1.25	1.134	0.12	2.51	0.291	2.231	2.231	0.00		0.000	0.983	0.962	0.021	1.00	0.021	0.531	0.525	0.006	3.15	0.019	0.331
CS 40.6	Flat Top Wash WB Bridge #1312 Option B - Replacement	21-21	2.03			0.00		0.000	1.25	1.114	0.14	2.84	0.386	2.231	2.231	0.00		0.000	0.983	0.962	0.021	1.00	0.021	0.531	0.525	0.006	3.15	0.019	0.426
CS 40.7	Griffith Wash WB Bridge #369 Option B - Replacement	40-40	2.03			0.00		0.000	1.25	1.074	0.18	2.84	0.500	2.231	2.231	0.00		0.000	0.983	0.962	0.021	1.00	0.021	0.531	0.525	0.006	3.15	0.019	0.540
CS 40.8	SR-95 to Kingman Safety Improvements	11-43	18.10			0.00		0.000			0.00		0.000	2.231	1.38	0.85	2.81	2.389	0.983	0.941	0.042	4.32	0.181	0.531	0.511	0.020	3.15	0.063	2.633
CS 40.9	Kingman Area Safety and Mobility Improvements	43-55	37.80			0.00		0.000			0.00		0.000	2.627	0.35	2.28	3.11	7.078	1.275	1.23	0.045	6.3	0.284	0.914	0.415	0.499	4.17	2.081	9.443

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement					Bridge					Safety					Mobility					Freight					Total Performance Area Score
				Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	Existing Need	Post-Solution Need	Raw Score	Risk Factor	Factored Score	
CS 40.10	Kingman to US 93 Safety Improvements	55-74	19.50			0.00		0.000			0.00		0.000	4.496	3.88	0.61	0.97	0.595	0.967	0.962	0.005	6.36	0.032	2.087	1.252	0.835	4.39	3.666	4.292
CS 40.11	Willow Creek Safety Improvements	80-98	44.90			0.00		0.000			0.00		0.000	3.457	2.78	0.68	1.02	0.694	1.206	0.991	0.215	5.1	1.097	2.11	1.704	0.406	3.1	1.259	3.049
CS 40.12	Jolly Road Area Safety Improvements	98-108	9.49			0.00		0.000			0.00		0.000	2.120	0.42	1.70	1.38	2.346	0.847	0.748	0.099	3.84	0.380	1.341	1.086	0.255	2.68	0.683	3.410
CS 40.13	Anvil Rock Rd TI UP Bridge # 1610 Option B - Replacement	110-110	2.26			0.00		0.000	1.64	0.55	1.09	2.76	3.008	0.169	0.17	0.00		0.000	0.892	0.856	0.036	1.2	0.043	1.635	1.621	0.014	2.72	0.038	3.090
CS 40.15	Ash Fork to Williams Safety Improvements	143-160	40.10			0.00		0.000			0.00		0.000	5.147	1.49	3.66	1.66	6.072	1.868	1.166	0.702	6.55	4.598	4.874	3.279	1.595	4.84	7.720	18.390
CS 40.16	Williams Area Safety Improvements	160-168	13.70			0.00		0.000			0.00		0.000	1.223	0.78	0.44	2.12	0.931	0.807	0.803	0.004	4.36	0.017	1.285	1.193	0.092	3.39	0.312	1.260
CS 40.17	West Flagstaff Pavement Improvements Option B - Replacement	191-196	42.90	0.647	0.32	0.33	6.52	2.132			0.00		0.000	0.205	0.20	0.01	2.57	0.021	0.902	0.867	0.035	4.1	0.144	0.725	0.707	0.018	3.17	0.057	2.353

Emphasis Areas and Performance Effectiveness Scores

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement Emphasis Area						Bridge Emphasis Area						Safety Emphasis Area						Total Raw Score	Total Factored Score	Performance Effectiveness Score (100*Pts/Cost)	VMT/10,000	VMT Performance Effectiveness Score (PES x VMT/10,000)
				Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score					
CS 40.1	Colorado River Bridge #957	0-0	55			0		1.50	0.000	3.2	0.014	3.186	3.33	1.50	15.914	3.152	3.152	0		1.50	0.000	6.651	27.020	**49.1**	0.32	**15.7**
CS 40.2	Topock Area Pavement Improvements Option B - Replacement	3-8	42.9	0.045	0	0.045	3.53	1.50	0.238			0		1.50	0.000	3.152	2.769	0.383	2.79	1.50	1.603	1.486	5.065	**11.8**	6.51	**76.9**
CS 40.3	Stateline to SR-95 Safety Improvements	0-11	6.1			0		1.50	0.000			0		1.50	0.000	3.152	1.014	2.138	2.79	1.50	8.948	4.571	16.215	**265.8**	14.33	**3809.5**
CS 40.4	Franconia Wash WB Bridge #377 Option B - Replacement	13-13	2.26			0		1.50	0.000	1.25	1.094	0.156	2.84	1.50	0.665	2.231	2.231	0		1.50	0.000	0.339	1.148	**50.8**	0.02	**1.1**
CS 40.5	Illavar Wash EB Bridge #1310 Option B - Replacement	18-18	1.24			0		1.50	0.000	1.25	1.134	0.116	2.51	1.50	0.437	2.231	2.231	0		1.50	0.000	0.259	0.768	**61.9**	0.01	**0.7**
CS 40.6	Flat Top Wash WB Bridge #1312 Option B - Replacement	21-21	2.03			0		1.50	0.000	1.25	1.114	0.136	2.84	1.50	0.579	2.231	2.231	0		1.50	0.000	0.299	1.006	**49.5**	0.02	**0.9**
CS 40.7	Griffith Wash WB Bridge #369 Option B - Replacement	40-40	2.03			0		1.50	0.000	1.25	1.07	0.176	2.84	1.50	0.750	2.231	2.23	0		1.50	0.000	0.379	1.290	**63.5**	0.02	**1.1**
CS 40.8	SR-95 to Kingman Safety Improvements	11-43	18.1			0		1.50	0.000			0		1.50	0.000	2.231	1.381	0.85	2.810	1.50	3.583	1.762	6.216	**34.3**	43.12	**1480.8**
CS 40.9	Kingman Area Safety and Mobility Improvements	43-55	37.8			0		1.50	0.000			0		1.50	0.000	2.627	0.351	2.276	3.110	1.50	10.618	5.096	20.060	**53.1**	25.19	**1336.9**
CS 40.10	Kingman to US 93 Safety Improvements	55-74	19.5			0		1.50	0.000			0		1.50	0.000	4.496	3.447	1.049	0.970	1.50	1.526	2.502	5.818	**29.8**	32.60	**972.7**
CS 40.11	Willow Creek Safety Improvements	80-98	44.9			0		1.50	0.000			0		1.50	0.000	3.457	2.711	0.746	1.020	1.50	1.141	2.047	4.190	**9.3**	10.69	**99.7**
CS 40.12	Jolly Road Area Safety Improvements	98-108	9.49			0		1.50	0.000			0		1.50	0.000	2.12	0.42	1.7	1.380	1.50	3.519	3.754	6.929	**73.0**	12.89	**941.1**

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement Emphasis Area						Bridge Emphasis Area						Safety Emphasis Area						Total Raw Score	Total Factored Score	Performance Effectiveness Score (100*Pts/Cost)	VMT/10,000	VMT Performance Effectiveness Score (PES x VMT/10,000)
				Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score	Existing Corridor Need	Post-Solution Corridor Need	Raw Score	Risk Factor	Emphasis Factor	Factored Score					
CS 40.13	Anvil Rock Rd TI UP Bridge # 1610 Option B - Replacement	110-110	2.26			0		1.50	0.000	1.64	0.55	1.09	2.760	1.50	4.513	0.169	0.169	0		1.50	0.000	2.230	7.602	**336.4**	0.06	**21.6**
CS 40.15	Ash Fork to Williams Safety Improvements	143-160	40.1			0		1.50	0.000			0		1.50	0.000	5.147	1.489	3.658	1.660	1.50	9.108	9.613	27.499	**68.6**	24.41	**1673.6**
CS 40.16	Williams Area Safety Improvements	160-168	13.7			0		1.50	0.000			0		1.50	0.000	1.223	0.784	0.439	2.120	1.50	1.396	0.974	2.656	**19.4**	12.62	**244.6**
CS 40.17	West Flagstaff Pavement Improvements Option B - Replacement	191-196	42.9	0.647	0.32	0.327	6.52	1.50	3.198			0		1.50	0.000	0.205	0.197	0.008	2.570	1.50	0.031	0.715	5.582	**13.0**	13.71	**178.47**

Appendix F Project Prioritization Scores

Candidate Solution #	Candidate Solution Name	Milepost Location	Estimated Cost ($ millions)	Pavement		Bridge		Safety		Mobility		Freight		Total Factored Score	Risk Factors					Weighted Risk Factor	VMT Performance Effectiveness Score (PES x VMT/10000)	Prioritization Score
				Score	%	Score	%	Score	%	Score	%	Score	%		Pavement	Bridge	Safety	Mobility	Freight			
CS 40.1	Colorado River Bridge #957	0-0	55	0.000	0.0%	26.523	98.2%	0.000	0.0%	0.434	1.6%	0.062	0.2%	27.020	1.07	1.27	1.36	1.18	1.18	1.268	15.7	19.9
CS 40.2	Topock Area Pavement Improvements Option B - Replacement	3-8	42.9	0.397	7.8%	0.000	0.0%	3.623	71.5%	0.960	19.0%	0.085	1.7%	5.065	1.07	1.27	1.36	1.18	1.18	1.300	76.9	100.0
CS 40.3	Stateline to SR-95 Safety Improvements	0-11	6.1	0.000	0.0%	0.000	0.0%	14.921	92.0%	1.212	7.5%	0.082	0.5%	16.215	1.07	1.27	1.36	1.18	1.18	1.346	3809.5	5126.2
CS 40.4	Franconia Wash WB Bridge #377 Option B - Replacement	13-13	2.26	0.000	0.0%	1.108	96.5%	0.000	0.0%	0.021	1.8%	0.019	1.6%	1.148	1.07	1.27	1.36	1.18	1.18	1.267	1.1	1.3
CS 40.5	Illavar Wash EB Bridge #1310 Option B - Replacement	18-18	1.24	0.000	0.0%	0.728	94.8%	0.000	0.0%	0.021	2.7%	0.019	2.5%	0.768	1.07	1.27	1.36	1.18	1.18	1.265	0.7	0.9
CS 40.6	Flat Top Wash WB Bridge #1312 Option B - Replacement	21-21	2.03	0.000	0.0%	0.966	96.0%	0.000	0.0%	0.021	2.1%	0.019	1.9%	1.006	1.07	1.27	1.36	1.18	1.18	1.266	0.9	1.1
CS 40.7	Griffith Wash WB Bridge #369 Option B - Replacement	40-40	2.03	0.000	0.0%	1.250	96.9%	0.000	0.0%	0.021	1.6%	0.019	1.5%	1.290	1.07	1.27	1.36	1.18	1.18	1.267	1.1	1.4
CS 40.8	SR-95 to Kingman Safety Improvements	11-43	18.1	0.000	0.0%	0.000	0.0%	5.971	96.0%	0.186	3.0%	0.063	1.0%	6.220	1.07	1.27	1.36	1.18	1.18	1.353	1481.8	2004.6
CS 40.9	Kingman Area Safety and Mobility Improvements	43-55	37.8	0.000	0.0%	0.000	0.0%	17.696	88.2%	0.284	1.4%	2.081	10.4%	20.060	1.07	1.27	1.36	1.18	1.18	1.339	1336.9	1789.8
CS 40.10	Kingman to US 93 Safety Improvements	55-74	19.5	0.000	0.0%	0.000	0.0%	2.121	36.5%	0.032	0.5%	3.666	63.0%	5.818	1.07	1.27	1.36	1.18	1.18	1.246	972.7	1211.6
CS 40.11	Willow Creek Safety Improvements	80-98	44.9	0.000	0.0%	0.000	0.0%	1.835	43.8%	1.097	26.2%	1.259	30.0%	4.190	1.07	1.27	1.36	1.18	1.18	1.259	99.7	125.5

CS 40.12	Jolly Road Area Safety Improvements	98-108	9.49	0.000	0.0%	0.000	0.0%	5.865	84.6%	0.380	5.5%	0.683	9.9%	6.929	1.07	1.27	1.36	1.18	1.18	1.332	941.1	1253.9
CS 40.13	Anvil Rock Rd TI UP Bridge # 1610 Option B - Replacement	110-110	2.26	0.000	0.0%	7.521	98.9%	0.000	0.0%	0.043	0.6%	0.038	0.5%	7.602	1.07	1.27	1.36	1.18	1.18	1.269	21.6	27.4
CS 40.15	Ash Fork to Williams Safety Improvements	143-160	40.1	0.000	0.0%	0.000	0.0%	15.181	55.2%	4.598	16.7%	7.720	28.1%	27.499	1.07	1.27	1.36	1.18	1.18	1.279	1673.6	2141.2
CS 40.16	Williams Area Safety Improvements	160-168	13.7	0.000	0.0%	0.000	0.0%	2.327	87.6%	0.017	0.7%	0.312	11.7%	2.656	1.07	1.27	1.36	1.18	1.18	1.338	244.6	327.3
CS 40.17	West Flagstaff Pavement Improvements Option B - Replacement	191-196	42.9	5.330	95.5%	0.000	0.0%	0.051	0.9%	0.144	2.6%	0.057	1.0%	5.582	1.07	1.27	1.36	1.18	1.18	1.077	178.4	192.0